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Reclamation and Groundwater Restoration in the Uranium Milling Industry: An Assessment of UMTRCA, Title II

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Reclamation and Groundwater Restoration in the Uranium Milling Industry: An Assessment of UMTRCA, Title II

JOHN D. COLLINS*

| | | |
|-------|--|----|
| I. | Uranium Mill Tailings | 27 |
| II. | Congress Acts to Regulate Uranium Mill Tailings . . | 32 |
| III. | The Failure to Expeditiously Reclaim | 42 |
| IV. | Case 1: Homestake Mining Company Mill, New Mexico | 44 |
| V. | Case 2: United Nuclear Corporation's Church Rock Mill, New Mexico | 50 |
| VI. | Case 3: Quivira (Rio Algom) Mining Company's Ambrosia Lake Mill, New Mexico | 56 |
| VII. | Case 4: Western Nuclear Inc. (Phelps Dodge) Split Rock Mill, Wyoming | 60 |
| VIII. | Case 5: American Nuclear Corporation Gas Hills Uranium Mill, Wyoming | 66 |
| IX. | Case 6: Pathfinder Mines Corporation's Lucky Mc Uranium Mill, Wyoming | 74 |
| X. | Case 7: Kennecott Uranium Company's Sweetwater Uranium Mill, Wyoming | 78 |
| XI. | Case 8: The Atlas Corporation's Mill, Moab, Utah | 83 |
| XII. | The End of Delay | 91 |
| | Conclusion | 96 |

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Uranium mill tailings are a fine sand-like residue that remains after uranium is removed from raw uranium ore. These tailings emit radon gas. Seepage from unlined tailings piles also can pollute groundwater. In 1978, Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) to regulate the disposal and reclamation of uranium mill tailings.¹ This study examines the implementation of this legislation through eight case studies of uranium mills now being reclaimed. In the early 1990s, the Environmental Protection Agency (EPA) argued that delays in implementing this legislation violated the intent of Congress.² The eight cases examined here provide ample evidence that, indeed, this law has not been implemented expeditiously. Whether or not this delay violated the intent of Congress is a more difficult question that will be discussed below.

Since the early years of its implementation, UMTRCA was viewed as unjust and unnecessary by the uranium industry.³ The eight case studies presented here will provide detail on the nature of the environmental problems at each mill, as well as a regulatory history. These case studies should allow a clearer judgement on the questions of why reclamation is necessary and if the federal requirements for reclamation are just. The reclamation issue is complicated by the changed financial fortunes of the uranium industry and by the pre-law origins of some of the mill tailings and groundwater problems that the uranium industry faces.

The eight case studies also provide a good basis for judging the necessity, and fairness to taxpayers, of recent legislation which authorizes the government to help pay for reclamation at some private mills.⁴ This 1992 federal financial bailout might seem to

¹ Pub. L. No. 95-604, 92 Stat. 3021 (1978) (Title I is codified as amended at 42 U.S.C. § 7901 (1995). Title II is codified as amended in scattered sections of the Atomic Energy Act, 42 U.S.C. § 2011 (1995)).

² See Health and Environmental Standards for Uranium and Thorium Mill Tailings, 58 Fed. Reg. 60,340, 60,342-43 (1993) [hereinafter Health Standards]. See also *infra* text accompanying notes 110-112.

³ See, e.g., *Status of the Domestic Uranium Mining and Milling Industry: Hearing on the Effects of Imports Before the Subcomm. on Energy Research and Development of the Senate Comm. on Energy and Natural Resources*, 97th Cong., 1st Sess. 46-53 (1981) (statement of George B. Rice, American Mining Congress, Uranium Environmental Subcomm.); *Management of Commingled Uranium Mill Tailings: Hearings Before the Procurement and Military Nuclear Systems Subcomm. of the House Comm. on Armed Services*, 97th Cong., 2nd Sess. 498-529 (1982) (statements of George B. Rice and Jack Vogt on behalf of the American Mining Congress) [hereinafter *Commingled Tailings Hearings*]. This point is also made by several of the uranium companies examined in the case studies which follow.

⁴ Energy Policy Act of 1992, Pub. L. No. 102-486, §§ 1001-1004, 106 Stat. 2776,

confirm complaints by the uranium industry that UMTRCA imposes an unfair financial burden on private industry.⁵ Today, the uranium industry can also find some vindication for its long standing claim that the danger of radon emissions from mill tailings has been greatly exaggerated.⁶ Fifteen years of additional studies have not disproved the industry's contention that radon from uncovered tailings is a very minor public health threat.⁷

Initially, the major controversy between the uranium milling industry and federal regulators was over requirements for covering tailings once milling had stopped. The reason for the controversy was obvious. The greatest cost in reclaiming a uranium mill is in moving dirt. It is very expensive to recontour one hundred to two hundred acres of tailings and then cover these tailings with five to ten feet of earth, which in turn must be protected against erosion by specially selected rock.⁸

A new area of contention appeared in the 1990s. This dispute is over groundwater restoration. Compared to the costs of covering tailings, the costs of pumping a polluted aquifer are relatively minor. The problem the uranium industry faces is that it is very difficult to clean up contaminated groundwater. In some instances, years of pumping have only slightly reduced levels of contamination.⁹ Uranium companies have questioned whether the probable future use of much of this groundwater really justifies the time and effort required to clean it up.¹⁰ Regulations allow for an easing of groundwater clean-up standards in certain circumstances.¹¹ Thus, many companies now argue that, after a good faith effort, some of the more intractable groundwater problems should be resolved by administrative fiat.¹²

2946-48 (1992) (codified at 42 U.S.C. § 2296(a) (Supp. V 1993)).

⁵ See *infra* notes 68-72, 361-369 and accompanying text.

⁶ See, e.g., *Commingled Tailings Hearings*, *supra* note 3, *passim*.

⁷ See *infra* notes 21-40 and accompanying text.

⁸ A written protest from three companies over possible stricter cover requirements in 1989 noted: "Every additional foot of cover that must be placed over a tailings impoundment to reduce radon emissions represents many millions of dollars in costs to the industry." Comments of Rio Algom Mining Corporation, Quivira Mining Company, and Kerr-McGee Corporation in the Matter of National Emission Standards for Hazardous Air Pollutants 72-73 (May 15, 1989) (on file with EPA Air Docket, Docket No. A-79-11) [hereinafter Comments of Rio Algom, Quivira, and Kerr-McGee].

⁹ This is discussed in much greater detail in the case studies which follow.

¹⁰ E.g., *infra* note 253 and accompanying text.

¹¹ On the regulations governing the granting of Alternate Concentration Limits, see *infra* notes 214-217 and accompanying text.

¹² The issue of Alternate Concentration Limits is discussed in detail in the case

There are 19 private uranium mills licensed and supervised directly by the Nuclear Regulatory Commission (NRC). Another seven private mills are licensed by state governments in Texas, Colorado, and Washington State.¹³ All of these 26 mills have stopped operations, and most are in various stages of reclamation. The small number of private uranium mills and the wealth of detail available on the federally regulated mills suggested that a case study approach would be both possible and useful.¹⁴ The advantage of a case study is that one can see how different variables such as physical setting and regulatory history affect reclamation. The disadvantage is that the case studied may not be typical. This problem has been dealt with by examining a large percentage of the total cases. The eight cases examined here make up an important part of the total reclamation picture in the uranium milling industry. A case study approach would require far more justification if, for example, one were studying reclamation at the nation's more than 2,400 coal

studies which follow.

¹³ In 1959 Congress amended the Atomic Energy Act to create the Agreement State Program (Act of September 23, 1959, Pub. L. No. 86-373, 73 Stat. 688 (codified as amended at 42 U.S.C. § 2021 (1988 & Supp. V 1993)). This act allowed states to license and regulate uranium mills and/or, certain types of radioactive material. The requirement that state standards for uranium mills be at least compatible with federal standards was amended in 1978 by UMTRCA to require that state standards be "equivalent, to the extent practicable, or more stringent than" those imposed by the NRC. 42 U.S.C. § 2021(o) (1988). See generally Elisa J. Grammer, *The Uranium Mill Tailings Radiation Control Act of 1973 and NRC's Agreement State Program*, 13 NAT. RESOURCES LAW. 469, 500-22 (1981); Ronald H. Rosenberg, *Uranium Mining and Milling in Virginia: An Analysis of Regulatory Choice*, 4 VA. J. NAT. RESOURCES L. 81, 96-98, 101-09, 115-17 (1984).

Three states with uranium mills have chosen not to license these mills under the Agreement State Program. The NRC licenses mills in Utah, Wyoming and New Mexico. Wyoming and New Mexico were the two largest uranium producing states. New Mexico did license uranium mills until 1986 when it returned its licensing authority to the NRC. See *infra* notes 127-129 and accompanying text.

¹⁴ The NRC Public Document Room (NRC/PDR) is located at 2120 L Street N.W. in Washington, D.C. Here one can find a complete and current regulatory record of each of the 19 uranium mills licensed directly by the NRC. Unfortunately, the NRC does not keep complete copies of state inspection reports and other documents on the seven mills licensed by state governments. Presumably such records do exist in the files of the relevant state agencies.

Most of the documents cited in the eight case studies used here are found in the NRC/PDR. Paper copies of the documents may be examined and copied at the facility. Documents also may be ordered by phone, fax, computer, or by writing to U.S. Nuclear Regulatory Commission, Public Document Room, Washington, D.C. 20555. Citations from NRC documents will contain the accession number (ACN.) or the docket number (DKT.). The accession number is a unique identification number for a document. A document can also be located with the docket number (DKT.) and the date of the document.

mines.

In choosing cases an emphasis was given to on-going reclamation and unresolved reclamation problems.¹⁵ Four mills were not chosen because they had largely completed placing a permanent cover over their tailings, although they still had groundwater restoration work to do. Another mill, Plateau Resources' Shootaring Canyon Mill in Utah, had operated for only a few months in 1982, and had few tailings to reclaim.

The final choice was made from fourteen NRC regulated mills where reclamation work is still in progress: seven in Wyoming; four in New Mexico; three in Utah. From these fourteen mills, eight cases were chosen, some of which had been the most important uranium producers in the nation. Three of the four New Mexican cases were chosen because of this state's leading role in uranium production. Four cases were taken from Wyoming, and one from Utah. The mill chosen in Utah had been the largest producer in the state.

I. URANIUM MILL TAILINGS

Many of the large uranium mines operating in the western United States in the 1970s contained uranium mills on the site as part of their operation.¹⁶ These mills converted ore from the mine into uranium oxide, or yellowcake, which was then sent elsewhere for enrichment into nuclear fuel.¹⁷ At the mill, uranium ore was crushed, blended, and ground to the proper size for a leaching pro-

¹⁵ In choosing the case studies the seven state-regulated mills were not considered because of a lack of easy access to regulatory reports.

¹⁶ Uranium mines were both open pit and underground, depending on the depth of the ore deposit. In Wyoming large open pit uranium mines were typical. Whereas, about 70% of New Mexico's uranium production came from underground mines. With some exceptions, such as radon emissions from underground uranium mines, there is no federal law governing reclamation of uranium mines. Uranium mine reclamation is primarily a state responsibility. See John D. Collins, *Uranium Mine and Mill Tailings Reclamation in Wyoming—Ten Years After the Industry Collapsed*, 26 LAND & WATER L. REV. 489 *passim* (1991) (discussing the overlap of state and Federal regulations and regulatory activity in Wyoming).

¹⁷ For general descriptions of uranium mining, milling and the nuclear fuel cycle, see generally ANTHONY D. OWEN, *THE ECONOMICS OF URANIUM* 22-35 (1985); Rosenberg, *supra* note 13, at 83-88; Peter C. Monson, Comment, *Radioactive Air Pollution from Uranium Mining: Regulatory Abdication in the Face of Scientific Uncertainty*, 13 ENVTL. L. 545, 546-560 (1983); David Riccitiello, *Uranium Mining and Milling: A Primer*, 4 WORKBOOK 222 (1979); NATIONAL RESEARCH COUNCIL, *SCIENTIFIC BASIS FOR RISK ASSESSMENT AND MANAGEMENT OF URANIUM MILL TAILINGS* 11-13, 22-34, 54-58 (1986) [hereinafter NATIONAL RESEARCH COUNCIL].

cess that would extract the uranium. A ton of uranium ore would produce only one to five pounds of uranium oxide, leaving essentially a ton of residue. This residue, especially in its dried, sand-like form, is referred to as mill tailings.

After processing, a liquid residue remained that might typically contain 40% solids and 60% liquid.¹⁸ This solution contained sands and slimes (coarse and fine tailings), plus water and chemicals used to leach the uranium from the ore. This liquid slurry would then be pumped to a tailings impoundment. Later, some of the slurry water might be pumped back to the mill for re-use. As tailings impoundments were seldom lined, the liquid which remained in these impoundments would either evaporate or seep into the ground and any groundwater beneath. Although most of the uranium is removed from the ore in the milling process, the tailings residue contains much of the radioactivity of the original ore. This radioactivity comes from unextracted uranium, radium-226, thorium-230, and other trace metals. These radionuclides are found in tailings at hundreds of times the normal level in soil.¹⁹ Non-radioactive but potentially water polluting contaminants also are commonly found in tailings. These contaminants may include arsenic, molybdenum, lead, selenium, chloride, manganese, and sulfates.²⁰

A. The Radon Threat from Uranium Mill Tailings

The potential radiation danger from uranium mining and milling is from radon. Of the three radon isotopes, radon-222 is the biggest threat to public health.²¹ Radon-222 is an odorless and colorless radioactive gas produced when uranium decays. Uranium and its decay products are found widely throughout the world. Ordinarily, most radon-222 is generated below the surface and decays into

¹⁸ NATIONAL RESEARCH COUNCIL, *supra* note 17, at 29.

¹⁹ Riccitiello, *supra* note 17, at 227; MERRIL EISENBUD, ENVIRONMENTAL RADIOACTIVITY 177 (3d ed. 1987).

²⁰ Riccitiello, *supra* note 17, at 227; Environmental Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites, 48 Fed. Reg. 45,926, 45,928 (1983) [hereinafter Standards Licensed Sites].

²¹ Atoms of the element radon have 86 protons. There are only three known isotopes of radon. Radon-219 (actinon) and radon-220 (thoron) have extremely short half-lives which means that concentrations of these isotopes are very low and there is less danger of human exposure from their decay products. COMMITTEE ON THE BIOLOGICAL EFFECTS OF IONIZING RADIATIONS, NATIONAL RESEARCH COUNCIL, HEALTH RISKS OF RADON AND OTHER INTERNALLY DEPOSITED ALPHA-EMITTERS, BEIR IV 24-25 (1988) [hereinafter BEIR IV].

nongaseous radionuclides before it can migrate through the soil and enter the atmosphere.²² However, mining and milling of uranium ore removes the protective shield of earth and rock and produces a concentrated source of radioactivity above ground in the form of uranium ore and uranium mill tailings.²³

Radon-222 has a half-life of 3.8 days. If it is released into the atmosphere, either naturally or through mining and milling, some atoms of gaseous radon-222 can travel hundreds of miles before they decay into non-radioactive lead.²⁴ Once in the atmosphere, the decay products, or daughters, of radon-222 can attach to microscopic dust particles. When inhaled, these small particles may stick to the moist epithelial lining of the bronchi. Before being cleared from the bronchi by mucus, they can expose several types of lung cells to alpha radiation and increase the risk of lung cancer.²⁵

Numerous studies of underground miners exposed to radon daughters in the air of mines have shown an increased risk of lung cancer in comparison with non-exposed populations.²⁶ Abundant epidemiological and experimental data have established the carcinogenicity of radon's decay products. However, the risk to health from radon in environments with lower concentrations than underground uranium mines has not been adequately quantified and, in the mid-1990s, remains a subject of intense interest and debate.²⁷

²² OFFICE OF RADIATION PROGRAMS, U.S. ENVTL. PROTECTION AGENCY, FINAL RULE FOR RADON-222 EMISSIONS FROM LICENSED URANIUM MILL TAILINGS at 2-2, 3-6 (Background Information Document, Aug. 1986).

²³ *Id.* at 3-1 to 3-6.

²⁴ *Id.* at 2-2. The radon-222 decay process involves seven principal decay products before the radon-222 becomes nonradioactive lead-206.

²⁵ BEIR IV, *supra* note 21, at 27, 28; Rhonda S. Berger, *The Carcinogenicity of Radon*, 24 ENV'T. SCI. & TECH. 30, 30-31 (1990). The ray or particle emitted by a radionuclide is typically an alpha particle, a beta particle, or a gamma ray. Gamma rays are the most penetrating and tend to be the most hazardous when the source of radiation is outside the body. It may require lead or concrete to stop them. Alpha particles, on the other hand, cannot even penetrate the skin, and can be stopped by a thin piece of paper. Once an alpha-emitting source is inhaled or ingested, however, it is extremely damaging for the short distance it does travel. Alpha particles are high "linear energy transfer" (high-let) radiation. SCOTT SALESKA, NUCLEAR LEGACY at II-3 (Public Citizen, Critical Mass Energy Project, Sept. 1989).

²⁶ *E.g.*, Jonathan M. Samet & Richard W. Hornung, *Review of Radon and Lung Cancer Risk*, 10 RISK ANALYSIS 65 (1990); Jay H. Lubin et al., *Lung Cancer in Radon-Exposed Miners and Estimation of Risk from Indoor Exposure*, 87 J. NAT'L CANCER INST. 817 (1995). Laboratory animals exposed to radon daughters also develop lung cancer. BEIR IV, *supra* note 21, at 5, 24, 29; David J. Hanson, *Radon Tagged as Cancer Hazard by Most Studies, Researchers*, CHEM. & ENG. NEWS, Feb. 6, 1989, at 7, 8-9.

²⁷ Jonathan M. Samet, *Indoor Radon and Lung Cancer: Risky or Not?* 86 J. NAT'L

The subject holds great interest because naturally occurring radon is found in elevated concentrations in many indoor environments.²⁸ Questions about the risk from exposure to low levels of radiation, and how to quantify such risks, also lie at the heart of the political debate over the dangers of nuclear power and nuclear waste.²⁹

Extrapolations based on cancer rates for underground miners have been used to project the risk of lung cancer associated with indoor radon for the general population. The resulting risk projections have been startlingly large. These projections estimate around 15,000 lung cancer deaths per year because of radon exposure.³⁰ Such extrapolations, however, involve numerous assumptions which are extremely difficult to prove or disprove.³¹

CANCER INST. 1813 (1994) (discussing the major issues and methodological problems in the debate).

²⁸ Radon concentrations in an underground uranium mine might be five hundred to several thousand picocuries per liter (pCi/L) of air, or higher. 2 OFFICE OF RADIATION PROGRAMS, U.S. ENVTL. PROTECTION AGENCY, ENVIRONMENTAL IMPACT STATEMENT FOR NESHAPS RADIONUCLIDES at 11-5 to 11-11 (Sept. 1989); RAYE C. RINGHOLZ, URANIUM FRENZY 92-94, 169 (1989) (a picocurie is a trillionth of one curie, which is a measure of the rate of radioactive decay). U.S. houses, by comparison, contain an average radon concentration of 1 pCi/L, although concentrations vary widely. The EPA has suggested that remedial action be taken for indoor concentrations above 4 pCi/L. The mean concentrations among states in the United States range from less than 1 pCi/L to more than 8 pCi/L, although less than 1% of homes exceed 8 pCi/L. Lubin *et al.*, *supra* note 26, at 818.

A concentration of 1 pCi/L in a home would result in an estimated annual exposure of 1.5 rems to the bronchial epithelium. HENRY N. WAGNER & LINDA E. KETCHUM, LIVING WITH RADIATION 138 (1989). One study of uranium miners showed that they had been exposed to 40 rems per year for an average of ten years. *Id.* Rads and rems are used to measure radiation exposure. A rad is equal to 100 ergs of radiation energy absorbed per gram of matter. A rem is obtained by multiplying the exposure in rads by the relative biological effectiveness (RBE) of the radiation in question. SALESKA, *supra* note 25, at II-1.

²⁹ J. Samuel Walker, *The Controversy Over Radiation Safety*, 262 JAMA 664 (1989); WAGNER & KETCHUM, *supra* note 28, at 40-44, 155-165.

³⁰ Lubin *et al.*, *supra* note 26, at 823-24; Samet, *supra* note 27, at 1813; WAGNER & KETCHUM, *supra* note 28, at 139-40. Extrapolations based on known cancer deaths for underground miners lead to projections of about five fatal cancer deaths per year from licensed uranium mill tailings piles. OFFICE OF RADIATION PROGRAMS, *supra* note 22, at 6-9. See also EISENBUD, *supra* note 19, at 178.

³¹ These extrapolations usually are based on some variation of the no-threshold linear hypothesis. WAGNER & KETCHUM, *supra* note 28, at 41-42, 158-160; RICHARD WOLFSON, NUCLEAR CHOICES 70-73 (1991); SALESKA, *supra* note 25, at II-3 to II-5. This hypothesis would assume that, no matter how low the radiation exposure, there is an additional risk of cancer that accompanies any increased exposure. It also assumes that the excess risk is proportional to any dose. WAGNER & KETCHUM, *supra* note 28, at 158-59. If these assumptions were true then the same number of radiation caused

Beginning in the 1980s, a number of case studies were initiated to measure the risk from indoor radon directly and avoid the uncertainties involved in projections based on studies of uranium miners. One of the most recent of these studies took place in Missouri.³² This study took radon measurements for a year in homes of 538 non-smoking white women diagnosed with lung cancer. These were compared to radon measurements in the homes of 1,183 matched subjects, also living in Missouri, who did not have lung cancer. The findings from this and several other similar studies showed no statistical significance for associations between indoor radon and lung cancer.³³ Some other studies have shown contradictory results.³⁴ The authors of the Missouri study concluded that the magnitude of the lung cancer risk from radon levels commonly found in U.S. dwellings appears low.³⁵

This research and the current debate over the dangers of indoor radon have direct implications for assessing the radon danger posed by uncovered uranium mill tailings. Radon emissions from uncovered mill tailings piles are approximately at the same level that one would find in an underground uranium mine.³⁶ Both an underground mine and a mill tailings impoundment are concentrated source of radon emissions. However, the typical uranium mill tail-

cancers would occur among 100,000 people receiving 100 rems as among 100,000,000 people receiving 0.1 rem. *Id.* at 41.

In the particular case of uranium miners, these extrapolations also assume that the environment in a uranium mine is similar to that in a home. This may not be so as uranium miners were mainly men, not women or children. Most of these men smoked and worked in a dusty environment which in addition to radon daughters also exposed them to silica, arsenic, diesel exhaust and blasting fumes. Samet, *supra* 27, at 1813; Michael C.R. Alavanja et al., *Residential Radon Exposure and Lung Cancer Among Nonsmoking Women*, 86 J. NAT'L CANCER INST. 1829, 1829 (1994).

³² Alavanja et al., *supra* note 31.

³³ No link between lung cancer and indoor radon was found in past studies in China, Finland and Canada. *Id.* at 1830. A combined analysis of studies in China, Stockholm, Sweden, and New Jersey revealed no evidence of a radon related risk, despite nearly 1000 lung cancer cases available for analysis. *Id.*

³⁴ A slight increase in lung cancer related to increased radon levels was suggested in studies in New Jersey and in Stockholm, Sweden. *Id.* A strong correlation was reported in a national Swedish study. Goran Pershagen et al., *Residential Radon Exposure and Lung Cancer in Sweden*, 330 NEW. ENG. J. MED. 159 (1994). One major problem with all these case studies is sample size. Thousands of subjects would be required under realistic scenarios of measurement error and population mobility. Samet, *supra* note 27, at 1813; WAGNER & KETCHUM, *supra* note 28, at 159.

³⁵ Alavanja et al., *supra* note 31, at 1829.

³⁶ 1 OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, U.S. NUC. REG. COMM., DRAFT GENERIC ENVIRONMENTAL IMPACT STATEMENT ON URANIUM MILLING at 5 (April 1979) [hereinafter DRAFT GENERIC E.I.S.].

ings pile is not emitting radon into an enclosed environment, as is the case in an underground uranium mine. Radon from an open air tailings pile is quickly dispersed into the atmosphere. Depending on the distance from the tailings pile, radon concentrations are less than what one would find in many homes. Indeed, within a mile or less, radon concentrations usually fall to natural, outdoor background levels.³⁷

From the perspective of the mid-1990s, then, there appears to be no new evidence that would disprove the uranium industry's contention that the radon danger from isolated uranium mill tailings piles represents very little threat to the public health.³⁸ Of course, not all uranium mill tailings piles are isolated. As we shall see in the case studies which follow, some tailings piles are located in or near population centers. Also, up until the mid-1960s, when the awareness about radon's dangers became more widespread, uranium mill tailings were commonly used as a cheap fill to replace sand in construction projects.³⁹ In such cases, radon from tailings piles could definitely accumulate in enclosed spaces. Some buildings in Colorado where tailings had been used in construction had radon concentrations close to the level that would trigger evacuation in a uranium mine, and hundreds of times the recommended safe level.⁴⁰

II. CONGRESS ACTS TO REGULATE URANIUM MILL TAILINGS

The initial effort by Congress to address the uranium mill tailings problem came in 1971 when hearings were held on the use of mill tailings in construction projects.⁴¹ These hearings led to legislation which created a cooperative program with Colorado to clean up structures that had been built using mill tailings in the

³⁷ EISENBAUD, *supra* note 19, at 177; U.S. ENVTL. PROTECTION AGENCY, *supra* note 22, at 3-4. See also NATIONAL RESEARCH COUNCIL, *supra* note 17, at 2, 45-54.

³⁸ Examples of the uranium industry's view that the threat of radon has been greatly exaggerated are found in *Commingled Tailings Hearings*, *supra* note 6, *passim*; Comments of Rio Algom, Quivira, and Kerr-McGee, *supra* note 8, *passim*.

³⁹ H. PETER METZGER, *THE ATOMIC ESTABLISHMENT* 193 (1972); Grammer, *supra* note 13, at 478-79. The worst example occurred in Grand Junction, Colorado, where between 1952 and 1966 one uranium company donated some 200,000 tons of uranium mill tailings for use as fill material in building roads, sewers and foundations for homes and offices. METZGER, *supra* at 171-76.

⁴⁰ WOLFSON, *supra* note 31, at 217; See also METZGER, *supra* note 39, at 176.

⁴¹ *Use of Uranium Mill Tailings for Construction Purposes: Hearings Before the Raw Materials Subcommittee of the Joint Comm. on Atomic Energy*, 92d Cong., 1st Sess. (1971).

Grand Junction area.⁴² Grand Junction was the worst site of such contamination.

This first attempt by Congress to deal with the problems caused by uranium milling left two major tailings related problems unresolved. One problem was how to safely dispose of the 23 million metric tons of uranium mill tailings found at abandoned or inactive mill sites throughout the West.⁴³ The second problem was how to prevent this scenario from being repeated in the future. This problem was especially pressing in the mid-1970s, as a new uranium boom was underway.

A. Uranium Booms

The first uranium boom in the western U.S. took place in the 1950s. It started when government buying stations opened to encourage exploration and assure uranium supplies for the defense industry. These buying stations guaranteed purchase of all uranium produced, and the price offered assured a generous profit.⁴⁴ This boom ended in the late 1950s when the government announced that there would be no price increases through the mid-1960s and that it would not buy uranium from domestic reserves developed after 1958.⁴⁵

This period of government uranium purchases left 23 million metric tons of unreclaimed uranium mill tailings at some 20 defunct or abandoned uranium mills scattered throughout the West.⁴⁶ Another 55 million metric tons of tailings, that had also been produced under government contract were stored at mills that continued to operate through the lean years of the 1960s.⁴⁷

⁴² Pub. L. No. 92-314, 86 Stat. 222 (1972). See generally Charles H. Montange, *Federal Nuclear Waste Disposal Policy*, 27 NAT. RESOURCES J. 309, 338 (1987); H.R. REP. NO. 1480, 95th Cong., 2d Sess. pt. 1, at 11, 12 (1978), reprinted in 1978 U.S.C.C.A.N. 7433, 7434 (House Report 1480, parts 1 and 2, provides the basic legislative history for UMTRCA. There was no conference report).

⁴³ 1 DRAFT GENERIC E.I.S., *supra* note 36, at 2-2, 2-3; see also H.R. REP. NO. 1480, *supra* note 42, pt. 2, at 29-32, reprinted in 1978 U.S.C.C.A.N. 7456-7459.

⁴⁴ See OWEN, *supra* note 17, at 38. See generally Michael A. Amundson, *Home on the Range No More*, 26 W. HIST. Q. 483, 484-87 (1995) (addressing the first uranium boom).

⁴⁵ OWEN, *supra* note 17, at 38-39; RINGHOLZ, *supra* note 28, at 208. At this same time new uranium discoveries were being made in Wyoming and New Mexico which added to government worries about excessive supplies of uranium. See generally *id.* at 179-83, 208; Amundson, *supra* note 44, at 487-88 (regarding the end of the first uranium boom).

⁴⁶ DRAFT GENERIC E.I.S., *supra* note 36, at 2-2, 2-3. The one abandoned uranium mill tailings site in the east was in Canonsburg, Pennsylvania.

⁴⁷ *Uranium Mill Tailings Reclamation Act of 1985: Joint Hearing on H.R. 2236*

As the transition to a private market was slow and difficult, some government purchasing of uranium continued until 1970.⁴⁸ The private-market demand came from the new nuclear power industry. Growth in new reactor orders was slowed in the late 1960s by organized public resistance to nuclear power,⁴⁹ and in the early 1970s by high energy prices which stifled the demand for electricity.⁵⁰

It was not until the mid-1970s that uranium prices took off and a second uranium boom began. Uranium oxide (yellowcake) sold for \$6.41 a pound in 1973, \$23.68 a pound in 1975, and for \$43.23 a pound in 1978.⁵¹ By 1978 there were 21 uranium mills operating in six western states.⁵² Some of these mills announced expansion plans.⁵³ Several companies were planning or constructing new mills. Eleven new mills were planned to start up in the late 1970s or early 1980s.⁵⁴ Such future milling activity promised to add millions of tons of tailings to the estimated 130 million metric tons accumulated by the late 1970s as a result of past milling for both the government and the private market.⁵⁵

and S. 1004 Before the Subcomm. on Energy and the Environ. of the House Comm. on Interior and Insular Affairs and the Subcomm. on Energy Research and Development of the Senate Comm. on Energy and Natural Resources, 99th Cong., 1st Sess. 197 (1985) [hereinafter *Joint Hearing*].

⁴⁸ OWEN, *supra* note 17, at 39; Amundson, *supra* note 44, at 491-92.

⁴⁹ See LUTHER J. CARTER, NUCLEAR IMPERATIVES AND PUBLIC TRUST 78-89 (1987).

⁵⁰ JOHN E. CHUBB, INTEREST GROUPS AND THE BUREAUCRACY: THE POLITICS OF ENERGY 96 (1983).

⁵¹ OWEN, *supra* note 17, at 42.

⁵² 1 DRAFT GENERIC E.I.S., *supra* note 36, at 3-3. One site in Florida extracted uranium as a by-product in the production of phosphoric acid for fertilizer. There were also five solution mining, or in-situ, operations producing uranium in Texas in 1978. These operations inject a leach solution into a subterranean uranium bearing ore body to dissolve and then extract the uranium. This process greatly reduces the residue that is produced in the traditional mining and milling process. *Id.* at 3-9, 3-11.

⁵³ *Id.* at 3-14.

⁵⁴ *Id.*

⁵⁵ *Id.* at 2-2. This would be about 140 million short tons (1 metric ton = 1.102 short tons = 2000 lbs). In 1978 about 80% of this total tailings accumulation was found at active mills that were then producing uranium and were licensed by the NRC. The rest of the tailings were stored at mills that had quit operating and whose licenses had expired. Such mills were often referred to as inactive or abandoned mill sites. *Id.*

B. A Federal Clean-up of Abandoned and Inactive Tailings

In 1974, a congressional committee proposed that the federal government join with the State of Utah to plan reclamation of the Vitro uranium mill tailings site in Salt Lake City.⁵⁶ Both the EPA and Atomic Energy Commission (AEC) endorsed this idea but suggested, instead, a comprehensive study of all abandoned and inactive uranium mill tailings sites found in the U.S.⁵⁷ This study became the basis for legislation authorizing a massive federal program to reclaim some 20 abandoned or inactive uranium mill tailings sites. This legislation was enacted in 1978 as Title I of the Uranium Milling Tailings Radiation Control Act.⁵⁸

C. New Federal Legislation for Operating Mills

The final tailings related problem facing Congress in the early 1970s was how to ensure safe disposal of tailings being produced at operating mills. The key to resolution already existed. It was the AEC (later NRC) license that each uranium mill had to have to operate.⁵⁹ In the 1970s this licensing authority was used to gradu-

⁵⁶ 1 OFFICE OF RADIATION PROGRAMS, U.S., ENVTL. PROTECTION AGENCY, FINAL ENVIRONMENTAL IMPACT STATEMENT FOR REMEDIAL ACTION STANDARDS FOR INACTIVE URANIUM PROCESSING SITES at 5-7 (Oct. 1982).

⁵⁷ *Id.* at 5; Montange, *supra* note 42, at 339.

⁵⁸ Pub. L. No. 95-604, 92 Stat. 3021 (1978) (Title I is codified as amended at 42 U.S.C. § 7901). *See generally* Grammer, *supra* note 13, at 481-88. Title I of UMTRCA specifically designated some twenty inactive uranium mill tailings sites to be reclaimed by the Department of Energy in cooperation with state governments. These sites contained a total of about 23 million metric tons of tailings, all of which were produced under contract to the federal government. Ninety percent of reclamation costs were to be paid for by the federal government and ten percent by the states in which the sites were located. 42 U.S.C. §§ 7911-7913, 7917. On Title I *see also* H.R. REP. NO. 1480, *supra* note 42, pt. 1, at 13, 18-19, *reprinted in* 1978 U.S.C.C.A.N. 7435, 7440-41, and pt. 2, at 30-32, *reprinted in* 1978 U.S.C.C.A.N. 7457-59.

Title I of UMTRCA also provided that nearby property contaminated with residual radioactive materials from the processing site could be designated for remedial action. 42 U.S.C. § 7912(e)(1). It is estimated that when completed in 1996 the reclamation of Title I inactive mill tailings sites will have cost tax payers \$1.4 billion. This cost does not include cleaning up contaminated groundwater which will be undertaken as a separate project. Paul Kemezis, *Mill Tailings Cleanup Progresses*, ENR, July 29, 1991, at 23. *See also* UMTRA PROJECT OFFICE, U.S. DEPT. OF ENERGY, DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR THE URANIUM MILL TAILINGS REMEDIAL ACTION GROUND WATER PROJECT (April 1995). The Department of Energy, Office of Environmental Restoration and Waste Management produces an ANNUAL STATUS REPORT ON THE URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM.

⁵⁹ *See generally* Blair P. Bremberg, *Financial Responsibility Requirements and the Implementation of Environmental Policy: The Case of the Uranium Mill Tailings Radia-*

ally incorporate new requirements into company licenses to ensure that mill tailings were disposed of in a safe and environmentally sound manner.⁶⁰ The legal basis for such action had been greatly expanded in 1970 with the passage of the National Environmental Policy Act (NEPA).⁶¹ The stimulus for this new concern with the environment came largely from the legal actions of environmental groups trying to force the AEC to implement NEPA.⁶²

When Congress acted in 1978 to deal with the problem of tailings at abandoned and inactive mill sites it was recognized that the tailings problem at operating mills had largely been resolved.⁶³ Nevertheless, to "clarify" and "reinforce" the NRC's authority over the production and disposal of tailings at operating mills, Congress added Title II to the Uranium Mill Tailings Radiation Control Act.⁶⁴

In UMTRCA, Title II, the EPA was designated to write the general standards that would govern reclamation at operating uranium mills.⁶⁵ NRC would then write specific rules and apply them to individual mills through the issuing and amending of licenses.⁶⁶ It was generally understood, however, that reclamation standards for operating uranium mills would follow guidelines that NRC had been developing since the early 1970s.⁶⁷ One of the most controversial

tion Control Act, 8 J. ENVTL. L. 171, 174-83 (1989).

⁶⁰ See H.R. REP. NO. 1480, *supra* note 42, pt. 1, at 12, *reprinted in* 1978 U.S.C.C.A.N. 7434; Montange, *supra* note 42, at 337-40.

⁶¹ National Environmental Policy Act of 1969, Pub. L. No. 91-190, §§ 101, 102, 83 Stat. 852, 852-54 (1970). See also Montange, *supra* note 42, at 338.

⁶² Montange, *supra* note 42, at 339; H.R. REP. NO. 1480, *supra* note 42, pt. 1, at 12, *reprinted in* 1978 U.S.C.C.A.N. 7434.

⁶³ See, e.g., H.R. REP. NO. 1480, *supra* note 42, pt. 2, at 30, *reprinted in* 1978 U.S.C.C.A.N. 7457.

⁶⁴ *Id.* pt. 1, at 13, *reprinted in* 1978 U.S.C.C.A.N. 7435, 7438. See also *id.* pt. 2, at 29, *reprinted in* 1978 U.S.C.C.A.N. 7456. Title II of UMTRCA added uranium mill tailings to the definition of byproduct materials and thus made uranium mill tailings a material that was licensable by the NRC. 42 U.S.C. § 2014(e) (1988).

⁶⁵ 42 U.S.C. § 2022 (1988).

⁶⁶ 42 U.S.C. § 2114 (1988). This division of authority followed a pattern developed in the early 1970s to assuage concern over the dual role played by the AEC, NRC's predecessor. The AEC had acted as both the promoter and regulator of nuclear energy. Richard Goldsmith, *Nuclear Power Meets the 101st Congress, A "One-Act" Comedy: Regulation of Nuclear Regulatory Commission Licensees Under the Clean Air Act*, 12 VA. ENVTL. L.J. 103, 103-06 (1992).

⁶⁷ See H.R. REP. NO. 1480, *supra* note 42, pt. 1, at 12, *reprinted in* 1978 U.S.C.C.A.N. 7434, 7435. See generally John Magee, Comment, *The Uranium Mill Tailings Radiation Control Act of 1978*, 8 ECOLOGY L.Q. 801, 805-06 (1980). Some parts of UMTRCA, Title II, did contain a new emphasis. Grammer stresses the increased federal control over the Agreement States that were authorized to license uranium mills.

aspects of UMTRCA, Title II, was the decision by Congress that private companies would have to pay for reclaiming all of the tailings stored at their mills, including the 55 million metric tons produced under government contract prior to 1970.⁶⁸ The legislative history of UMTRCA makes clear that Congress did not want its willingness to pay for reclamation at Title I, unlicensed (abandoned and inactive), uranium mill sites taken as a precedent for other federally financed clean-ups.⁶⁹ The House reports on UMTRCA emphasized that the issue of Title I sites was a unique case. After milling had stopped, these unlicensed sites escaped governmental control because at the time the hazards of tailings were not understood.⁷⁰ This "loophole in the law," it was argued, clearly did not exist at operating mill tailings sites.⁷¹ "Those sites, even those with tailings derived from federal contracts, are subject to NRC regulation as a result of the enactment of NEPA in 1970."⁷²

D. The Regulations Implementing UMTRCA, Title II

In the late 1970s, the NRC had been working on a generic environmental impact statement on uranium milling.⁷³ Thus, the Agency was able to produce the rules implementing UMTRCA by 1980.⁷⁴ This was well before EPA produced its general standards and before the new Republican Administration and the Republican

Grammer, *supra* note 13, at 506-20. Bremberg states that: "The hallmark of UMTRCA is the financial responsibility requirement. . . . [which] requires mill licensees to post financial sureties to ensure performance of approved decommissioning and reclamation plans." Bremberg, *supra* note 59, at 173.

⁶⁸ 42 U.S.C. § 7925 (1988). See also REP. H.R. NO. 1480, *supra* note 42, pt. 2, at 30, reprinted in 1978 U.S.C.C.A.N. 7457; COMPTROLLER GENERAL, U.S. GEN. ACCOUNTING OFFICE, CLEANING UP COMMINGLED URANIUM MILL TAILINGS: IS FEDERAL ASSISTANCE NECESSARY? (Feb. 5, 1979) (recommending financial assistance to active mill operators for cleaning up tailings produced under Federal contract).

⁶⁹ H.R. REP. NO. 1480, *supra* note 42, pt. 2, at 28, 30, reprinted in 1978 U.S.C.C.A.N. 7455, 7457.

⁷⁰ *Id.* pt 2, at 30, reprinted in 1978 U.S.C.C.A.N. 7457.

⁷¹ *Id.*

⁷² *Id.*

⁷³ DRAFT GENERIC E.I.S., *supra* note 36; OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, U.S. NUC. REG. COMM., FINAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON URANIUM MILLING (Sept. 1980) [hereinafter FINAL GENERIC E.I.S.].

⁷⁴ Uranium Mill Licensing Requirements, 44 Fed. Reg. 50,015 (1979) (proposed Aug. 24, 1979); Uranium Mill Licensing Requirements, 45 Fed. Reg. 65,521 (1980) (final rules) (codified at 10 C.F.R. §§ 30, 40, 70, 150). NRC discusses the process for developing regulations and gives its justification for issuing regulations as soon as possible in 45 Fed. Reg. 65,521, 65,523 (1980).

Senate came to power in 1981. As soon as the NRC rules appeared, they were challenged in court by Kerr-McGee and several other uranium companies.⁷⁵

The legal challenge to the new regulations failed, but efforts by the uranium industry to get Congress to intervene were more successful. In 1982, Congress amended an appropriations bill to forbid the NRC from any spending to implement the mill tailings regulations.⁷⁶ In January 1983, however, new legislation restored the NRC's authority.⁷⁷ EPA issued final standards in October 1983, more than three years after the original Congressional deadline.⁷⁸ Both environmental groups and industry appealed, but the standards were upheld in the Tenth Circuit Court of Appeals.⁷⁹ Where necessary, the NRC changed its existing rules to conform to the new EPA general standards.⁸⁰

The regulatory emphasis implementing UMTRCA was on new mills. This proved to be a mistake because few of the planned mills ever opened. Most of those that did open had ceased operations by the early 1980s.⁸¹ The "general goal" or "broad objective" of the

⁷⁵ *Kerr-McGee Nuclear Corp. v. N.R.C.*, [1982] 17 Env't Rep. Cas. (BNA) 1537 (Mar. 23, 1982). The companies in this case argued the regulations were too stringent and expensive given the slight risks from radon emissions. The petitioners also asserted that the NRC had usurped the authority of the EPA by issuing regulations to implement UMTRCA before the general standards appeared. Montange, *supra* note 42, at 345. On the complex political and legal machinations surrounding these NRC regulations, see Elizabeth V. Scott, Note, *Unfinished Business: The Regulation of Uranium Mining and Milling*, 18 U. RICH. L. REV. 615, 629-30 (1984); Montange, *supra* note 42, at 344-48.

⁷⁶ Energy and Water Development Appropriation Act of 1982, Pub. L. No. 97-88, tit. IV, 95 Stat. 1135, 1147-48 (1981). See also Scott, *supra* note 75, at 629; Montange, *supra* note 42, at 345.

⁷⁷ Nuclear Regulatory Commission Appropriations Authorization, Pub. L. No. 97-415, 96 Stat. 2067, 2077-78 (1983).

⁷⁸ Standards Licensed Sites, *supra* note 20. These standards are codified at 40 C.F.R. § 192, subpts. D & E (1983).

⁷⁹ *American Mining Congress v. Thomas*, 772 F.2d 640 (10th Cir. 1985), *cert. denied* 479 U.S. 814 (1986). The EPA had also promulgated general standards for the Title I, inactive mills that were to be reclaimed by the Department of Energy. The court did not uphold the groundwater standard for the Title I sites and ruled that EPA must issue groundwater standards for inactive sites rather than proceed on a case-by-case basis. See *Health Standards*, *supra* note 2. *American Mining Congress v. Thomas*, 772 F.2d 617 (10th Cir. 1985), *cert. denied* 426 U.S. 1158 (1986).

⁸⁰ *Uranium Mill Tailings Regulations*, 50 Fed. Reg. 41,852 (1985), and *Uranium Mill Tailings Regulations*, 52 Fed. Reg. 43,553 (1987). These NRC regulations are codified at 10 C.F.R. § 40, app. A (1987). In *Quivira Mining Co. v. N.R.C.*, 866 F.2d 1246 (10th Cir. 1990) the court upheld NRC's 1985 rule changes. A new challenge to NRC's 1987 rules also failed. *American Mining Congress v. N.R.C.*, 902 F.2d 781 (10th Cir. 1990). See generally *Health Standards*, *supra* note 2, at 60,341, 60,344-45.

⁸¹ See *infra* text accompanying notes 114-119.

regulations was to avoid future environmental problems through a wise choice of isolated sites for new tailings impoundments and through new designs.⁸² Below grade tailings impoundments would be one example of a new design which eliminated the need for retention structures that might fail.⁸³ New tailings impoundments would also be lined to prevent seepage.⁸⁴

The final reclamation of a tailings impoundment involved drying the tailings and then covering them to prevent infiltration or dispersal by rain, wind, snow, or flood. The permanent earthen cover had to be of sufficient depth so that radon emissions from the reclaimed tailings would not exceed twenty picocuries per square meter per second (20 pCi/m²/s).⁸⁵ The cover had to be of sufficient strength to keep the tailings undisturbed for at least 200 years, and longer if this could be reasonably achieved.⁸⁶ Long-term protection would be supplied by a self sustaining vegetative or rock cover over the earthen cover.⁸⁷ Erosion from water runoff would be minimized by contouring the dried tailings to reduce steep slopes.⁸⁸ "In addition to rock cover on slopes, areas toward which surface runoff might be directed must be well protected with substantial rock cover (rip rap)."⁸⁹

The regulations seemed to encourage moving existing tailings to a more isolated and secure site for final disposal.⁹⁰ In deciding whether or not to move the tailings, the following features had to be considered: remoteness from populated areas; long-term threat to

⁸² 10 C.F.R. § 40, app. A, technical criteria 1 and 4 (1995).

⁸³ *Id.* at criterion 3.

⁸⁴ *Id.* at criterion 5A. New tailings impoundments were also required to have leak detection systems below the liners to ensure that major failures in the liner would be detected. *Id.* criterion 5E(1). A drainage system was to be installed at the bottom of the impoundment for dewatering the tailings. *Id.* criterion 5E(3).

⁸⁵ 10 C.F.R. § 40, app. A, criterion 6 (1994). The criterion 6 regulations were changed in 1995 to require actual verification that the 20 pCi/m²/s limit had been achieved. 10 C.F.R. § 40, app. A, criterion 6 (1995). *See generally infra* notes 516, 533.

Radon emissions from unreclaimed and uncovered tailings commonly range from 300 to 500 pCi/m²/s. Standards Licensed Sites, *supra* note 20, at 45,931. Radon concentration in air is generally described in terms of picocuries per liter (pCi/L). *See supra* note 28. The rate of emanation, or flux, of radon from a surface is defined as the rate at which radon atoms enter the atmosphere across a unit area of that surface per unit time. This may be described in terms of picocuries of radon per square meter per second (pCi/m²/s). NATIONAL RESEARCH COUNCIL, *supra* note 17, at 34, 35.

⁸⁶ 10 C.F.R. § 40, app. A, criterion 6 (1995).

⁸⁷ *Id.* at criterion 4(d).

⁸⁸ *Id.* at criteria 4(c), 4(d).

⁸⁹ *Id.* at criterion 4(d).

⁹⁰ *Id.* at criteria 1, 3, 4. *See Montange, supra* note 42, at 353-56.

groundwater; and ability to minimize natural forces that might erode, disturb, or disperse reclaimed tailings.⁹¹ The regulations state that, in judging the adequacy of an existing site, "primary emphasis must be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration of only short-term convenience or benefits such as minimization of transportation or land acquisition costs."⁹² The regulations also reflect Congress's view that these sites should be permanently reclaimed so that active maintenance is not necessary to preserve the site.⁹³

Existing tailings impoundments were exempt from the requirement that tailings impoundments be lined.⁹⁴ Otherwise, older mills would have had to shut down operations and build new impoundments. The regulations did state that, by October 1, 1984, existing mills had to have a monitoring program in place to protect groundwater.⁹⁵ The quality of water upgradient of the tailings site would be used to establish site specific groundwater protection standards.⁹⁶ If leakage from a tailings impoundment were detected, then the operator had 18 months to establish a groundwater corrective action program.⁹⁷ The program had to restore groundwater to its original quality⁹⁸ and in doing so "the program must address removing the hazardous constituents that have entered the groundwater at the point of compliance or treating them in place."⁹⁹

⁹¹ 10 C.F.R. § 40, app. A, criterion 1 (1995). *See also id.* at criteria 3, 4(a), 4(b), 4(e).

⁹² *Id.* at criterion 1. However, in 1983 Congress amended UMTRCA instructing the NRC to consider economic costs as one factor in making reclamation decisions. Nuclear Regulatory Commission Appropriations Authorization, Pub. L. 97-415, 96 Stat. 2067, 2080 (1983) (codified as amended at 42 U.S.C. § 2022(b)(1) (1988)). Thus, the introduction to NRC's regulations now reads: "All site specific licensing decisions based on the criteria in this Appendix . . . will take into account the risk to the public health and safety and the environment with due consideration to the economic costs involved and any other factors the Commission determines to be appropriate." 10 C.F.R. § 40, app. A, intro. (1995).

⁹³ 10 C.F.R. § 40, app. A, criterion 1, (1995). *See* H.R. REP. NO. 1480, *supra* note 42, pt. 1, at 16, pt. 2, at 71, *reprinted in* 1978 U.S.C.C.A.N. 7439, 7471.

⁹⁴ 10 C.F.R. § 40, app. A, criterion 5A(1) (1995). In its administration of the Clean Air Act, the EPA has since the early 1990's required that operational uranium mill tailings impoundments be lined. *See infra* notes 518-528 and accompanying text.

⁹⁵ 10 C.F.R. § 40, app. A., criterion 7A (1995).

⁹⁶ *Id.* *See also id.* at criteria 5B, 5C, 5D.

⁹⁷ *Id.* at criterion 5D.

⁹⁸ *See id.* at criteria 5D, 5F.

⁹⁹ *Id.* at criterion 5D. On the regulations governing groundwater restoration, *see generally* John L. Watson, *Groundwater Issues Affecting the Mining and Milling Industries*, in *GROUND WATER CONTAMINATION*, Paper No. 15, at 15-29 to 15-35 (Rocky Mt. Min. L. Fdn. 1991).

Finally, the regulations required each operator to establish financial sureties so that sufficient funds would be available to complete reclamation.¹⁰⁰ The surety would be reviewed annually by the NRC to assure that enough money would be available to finish reclamation if the work had to be performed by an independent contractor.¹⁰¹

Objections to the final rules implementing UMTRCA, Title II, came mainly from environmental groups. They complained that, under the Reagan Administration, the allowable radon emissions level from reclaimed tailings impoundments was ten times greater than that originally set by the NRC in 1980.¹⁰² In 1980, the NRC also had required that the protective tailings cover be constructed so as to last "thousands of years."¹⁰³ This was changed by the Reagan-era EPA to "at least 200 years."¹⁰⁴ Questions were also raised as to why the UMTRCA standards set no specific limits for radon emissions from operating tailings piles.¹⁰⁵ The only specific radon limit was the 20 pCi/m²/s limit on emissions after the tailings had been reclaimed.¹⁰⁶

A final criticism concerned the Clean Air Act. The Reagan-era EPA maintained that the standards developed for UMTRCA also satisfied the Clean Air Act requirements for regulating

¹⁰⁰ 10 C.F.R. § 40, app. A, criterion 9 (1995).

¹⁰¹ *Id.*

¹⁰² See, e.g., Chris Shuey, *Bringing Tailings Under Control*, 10 WORKBOOK 110, 111 (1985); Standards Licensed Sites, *supra* note 20, at 45,937. The emission standard set by EPA for reclaimed tailings was 20 pCi/m²/s. See *supra* text accompanying note 85. In 1980 it had been set at 2 pCi/m²/s by the NRC. Uranium Mill Licensing Requirements, *supra* note 74, at 65,528, 65,534. In Colorado, an Agreement State, the 2 pCi/m²/s standard for reclaimed tailings has been retained. 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 4-50.

¹⁰³ Uranium Mill Licensing Requirements, 45 Fed. Reg. 65,521, 65,528 (1980).

¹⁰⁴ The actual wording is: "Be effective for one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years." Standards Licensed Sites, *supra* note 20, at 45,947 (codified at 40 C.F.R. § 192.32 (1994)). See also 10 C.F.R. § 40 app. A, criterion 6 (NRC regulations covering same subject). In fact, EPA calculated that it would require about 265,000 years for the radon-222 emissions from existing piles to be reduced to 10% of its initial value. OFFICE OF RADIATION PROGRAMS, *supra* note 22, at 3-13.

¹⁰⁵ See, e.g., Standards Licensed Sites, *supra* note 20, at 45,936.

¹⁰⁶ The EPA explained in 1983 that a radon emissions limit for operating tailings impoundments was not practical because of the varied conditions that occurred at different sites and during different phases of a milling operation. Instead of setting a specific limit, EPA anticipated that companies would follow regulations for uranium mills adopted by the NRC in the late 1970s which mandated that all tailings impoundments limit radon to as low as reasonably achievable (ALARA) limits. *Id.*

radionuclides.¹⁰⁷ Environmental groups disagreed and went to court. The results of this litigation were to have a great impact on UMTRCA's implementation in the 1990s.¹⁰⁸

Thanks to the new Reagan-era EPA, uranium companies had fewer complaints about reclamation standards than they had earlier. Also, by the early 1980s, the uranium industry was concerned with more pressing problems than reclamation standards.¹⁰⁹

III. THE FAILURE TO EXPEDITIOUSLY RECLAIM

In the 1990s, the EPA criticized the lassitude with which the private uranium milling industry had addressed reclamation in the 1980s.¹¹⁰ In a veiled reproach to NRC's regulatory practices, the EPA argued that delays in implementing UMTRCA violated the intent of Congress. According to the EPA, the legislative history and actions of Congress confirm "UMTRCA's purpose to require expeditious public health protection."¹¹¹ "Expeditious control of disposed tailings was paramount."¹¹²

The EPA is correct in at least one of its assertions. One of the most striking features in the history of UMTRCA was the slow pace and hesitancy of its implementation. The eight case studies which follow will show that after milling stopped, it was essentially the companies that determined when reclamation would begin and at what pace it would proceed. It is much less clear if this failure to expeditiously reclaim can be considered a violation of the intent of Congress. Attitudes of Congress and of the Executive changed in the early 1980s. The emergence of a new indifference to rapid reclamation can be explained by two important events: (1) Ronald Reagan was elected President, and (2) the bottom fell out of the uranium market.

The Reagan Administration showed a new empathy for the problems facing corporate America in general, and the mining industry in particular.¹¹³ In the early 1980s uranium producers need-

¹⁰⁷ *Id.* at 45,939-40.

¹⁰⁸ See *infra* text accompanying notes 501-525.

¹⁰⁹ See *infra* notes 114-119 and accompanying text.

¹¹⁰ See, e.g., Health Standards, *supra* note 2, at 60,341-43, 60,349.

¹¹¹ *Id.* at 60,342. See also *id.* at 60,343-44, 60,349; Health and Environmental Standards for Uranium and Thorium Mill Tailings, 58 Fed. Reg. 32,174, 32,176-78 (1993) (proposed rule).

¹¹² Health Standards *supra* note 2, at 60,343.

¹¹³ See Paul R. Portney, *Natural Resources and the Environment, in THE REAGAN*

ed understanding from government. Uranium prices had crashed in 1980 and failed to recover.¹¹⁴ Prices fell from over \$40 per pound of uranium oxide in the late 1970s, to \$25 by 1980, and to \$17 per pound by 1982.¹¹⁵ Prices for uranium oxide remained below \$20 a pound through most of the 1980s and in 1989 dipped below \$10 a pound, remaining at this historically-low level to the mid-1990s.¹¹⁶ The jobs lost in the uranium mining and milling bust of the early 1980s never came back,¹¹⁷ although some companies with long-term contracts maintained production at low levels through the late 1980s.¹¹⁸ Most uranium mining stopped. It simply did not pay to mine existing reserves.¹¹⁹ Such a situation was completely unforeseen in the uranium legislation Congress had enacted only a few years earlier.

In UMTRCA, Title II, Congress emphasized the proper siting and construction of new lined tailings impoundments. This was how public health and the environment were to be protected from uranium mill tailings. The future, however, did not conform to this mod-

RECORD 141 (John L. Palmer & Isabel V. Sawhill eds., 1984); James L. Regens et al., *Deja Vu and Western Energy Development*, in *ENERGY AND THE WESTERN UNITED STATES* 183 (James L. Regens et al. eds., 1982); Donald C. Menzel, *Redirecting the Implementation of a Law: The Reagan Administration and Coal Surface Mining Regulation*, 43 PUB. ADMIN. REV. 411 (1983).

¹¹⁴ The uranium bust has been blamed on collapsed cartels, huge stockpiles, Three Mile Island, and growing foreign competition. See generally *Domestic Uranium Mining and Milling: Hearing Before the Subcomm. on Nuc. Regulation of the Senate Comm. on Environment and Public Works*, 98th Cong., 1st Sess. 467 (1983) [hereinafter *Domestic Uranium Hearing*]; OWEN *supra* note 17, at 54, 55; H. Hamilton Hackney III, Comment, *Recent Congressional Proposals for Providing Relief to the Domestic Uranium Industry: Saving Grace or Just Another Expensive Bailout?* 10 J. ENERGY L. & POL'Y 171, 177-80 (1990).

¹¹⁵ A.D. Owen, *Short-Term Price Formation in the U.S. Uranium Market*, 6 ENERGY J. 37, 41 (1985).

¹¹⁶ See *id.*; George White, Jr., *Uranium: Price Plunge Continues*, *ENGIN. & MINING J.*, Mar. 1990, at 59; Thomas C. Pool, *Uranium: A Lackluster Year*, *ENGIN. & MINING J.*, Mar. 1995, at 78-80. In mid-1995 prices for uranium oxide rose above \$10 a pound for the first time since the late 1980's. Ray E. Harris, *Industrial Minerals and Uranium Update*, WYO. GEO-NOTES, Aug. 1995, at 32.

¹¹⁷ For example, in Wyoming total employment in the uranium industry went from 5,000 in March 1980, to under 2,500 by December 1981. The employment level was below 1,000 by the end of 1984, and by 1986 only 435 people in the state were employed in the industry. WYO. MINING ASS'N, WYOMING MINERAL INDUSTRY FACTS 1985 at 40 (1986).

¹¹⁸ See James W. Sanguinetti, *The U.S. Production Industry 3* (Sept. 1988) (paper presented at USCEA Uranium Seminar 1988, available from U.S. Council for Energy Awareness (USCEA), Washington, D.C.); *Domestic Uranium Hearing*, *supra* note 114, at 48.

¹¹⁹ *Domestic Uranium Hearing*, *supra* note 114, at 18.

el. In the 1980s, rather than supervise construction of new mills, the NRC had to preside over the slow death of an industry. Congressional hearings in the 1980s make clear Congress's concern and compassion for beleaguered uranium producers.¹²⁰ This concern was shared by the Reagan Administration. No one at the time was opposed to expeditious reclamation, but neither were the uranium companies going to be forced to reclaim if they did not want to. This government tolerance characterized reclamation during most of the 1980s.

IV. CASE 1: HOMESTAKE MINING COMPANY MILL, NEW MEXICO

A. Introduction

Throughout the 1980s, Homestake had problems with radon emissions and airborne contaminants.¹²¹ The threat posed by blowing tailings and radon emissions was greatly increased by the fact that several housing estates had been built near the mill.¹²² In addition, the usual means for controlling radon emissions could not be employed because of the construction design used for the Homestake tailings impoundment.¹²³

The tailings at Homestake are now being covered with soil, which will control the radon problem. This, however, will not eliminate the threat these tailings could pose to the surrounding environment. The Homestake tailings will be reclaimed where they stand, on the floodplains of the San Mateo Creek and Lobo Canyon.¹²⁴ Liquids leaking from the unlined tailings piles into the groundwater are the final danger this mill presents to the environment and nearby residents. This problem has been more amenable to solution, thanks to unusual persistence and considerable expense on the part of

¹²⁰ For a description of these hearings and the various schemes proposed in Congress to aid the stricken uranium industry, see Hackney, *supra* note 114, at 185-96. See also DANIEL BORSON, *FOREVER IN ITS DEBT* 6-8 Public Citizen, Critical Mass Energy Project, June 1989; Collins, *supra* note 16, at 494.

¹²¹ See *infra* notes 135-148 and accompanying text.

¹²² In 1989 EPA reported there were 187 people living within one to two kilometers of the Homestake tailings impoundment and 390 people living within five kilometers of the tailings. 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 9-11.

¹²³ Petition from the Homestake Mining Co. for Reconsideration and Stay from National Emission Standards for Hazardous Air Pollutants 4, 7-8 (Feb. 13, 1990) (on file with EPA Air Docket, Docket No. A-79-11) [hereinafter Petition]. See also *infra* notes 140-148 and accompanying text.

¹²⁴ See *infra* notes 173-177 and accompanying text.

Homestake.¹²⁵

The Homestake mill began operations in 1958.¹²⁶ In 1974, New Mexico signed with the NRC as an "Agreement State" and took over regulation of uranium milling activities.¹²⁷ The agreement lasted until June 1986, when New Mexico gave up regulating uranium milling due to high costs.¹²⁸ The state also had tired of battling in the courts and the legislature while trying to get mill owners to clean up tailings.¹²⁹

Homestake closed operations in 1990.¹³⁰ Most uranium mills had closed earlier when uranium prices crashed in the early 1980s. By the mid-1980s, Homestake was the only mill out of five in New Mexico still operating.¹³¹ In its last year it operated at only 20% of capacity.¹³²

Tailings produced at Homestake were placed in two unlined piles. The smaller tailings pile has not been used since 1962 and contains about 1.2 million tons of tailings.¹³³ The larger pile contains more than 21 million tons of tailings.¹³⁴

¹²⁵ See *infra* notes 149-172 and accompanying text.

¹²⁶ Petition, *supra* note 123, at 3.

¹²⁷ OFFICE OF EMERGENCY AND REMEDIAL RESPONSE, U.S. ENVTL. PROTECTION AGENCY, SUPERFUND RECORD OF DECISION: HOMESTAKE MINING, NM at 2 (Sept. 1989) [hereinafter HOMESTAKE R.O.D.]. See also, *supra* note 13.

¹²⁸ Reassertion of Certain Regulatory Authority in the State of New Mexico, 51 Fed. Reg. 19,432 (1986).

¹²⁹ See Nolan Hester, *State Quits Tailings Cleanup Fight*, ALBUQUERQUE J., May 11, 1986, at C1. See generally Grammer, *supra* note 13 at 505, 511-14.

¹³⁰ U.S. Envtl. Protection Agency, *Transcript of Public Hearings on National Emission Standards for Hazardous Air Pollutants*, at 111 (Santa Fe, N.M., Jan. 21-22, 1992) (testimony of Mark Hiles, Homestake Mining Co.) (on file with EPA Air Docket, Docket No. A-91-67) [hereinafter *Public Hearings*].

¹³¹ Steve Hinchman, *In New Mexico's Uranium Belt: Rebottling the Nuclear Genie*, HIGH COUNTRY NEWS, Jan. 19, 1987, at 6.

¹³² See Letter from Ramon Hall, Director NRC Region IV, to Homestake Mining Co (attn. Mr. Richard Farrell) at 5 (Dec. 21, 1989) (on file with NRC/PRD, ACN. 9001030079); Petition, *supra* note 123, at 3.

¹³³ HOMESTAKE R.O.D., *supra* note 127, at 1; Petition, *supra* note 123, at 112.

¹³⁴ Letter from F.R. Craft, Homestake Mining Co., to Ramon Hall, NRC, with Attached Specifications for Recontouring of the Large Tailing Impoundment attach. at 1 (June 29, 1992) (on file with NRC/PDR, ACN. 9209210200); HOMESTAKE R.O.D., *supra* note 127, at 1.

B. Excessive Radon Emissions and Blowing Tailings

Residents who lived near Homestake were quoted by one journalist as saying that "gales whip sands off the pile in plumes that can stretch six miles."¹³⁵ In 1987, Homestake began using a chemical stabilizer to control blowing tailings. After an inspection in November 1988, the NRC called the program "ineffective," and issued a Notice of Violation when excessive blowing of tailings was observed.¹³⁶ In addition to chemical stabilizers, Homestake also tried erosion control blankets, sprinklers, and even old tires to control the blowing tailings.¹³⁷

In 1989 an EPA study concluded that the lifetime fatal cancer risks for individuals living near uranium mills that were operating or on standby was greatest at Homestake.¹³⁸ When the EPA set new radon emission standards for tailings piles at operating mills in December 1989, Homestake stated that it would be impossible to meet these standards.¹³⁹

The design of the Homestake tailings impoundment precludes the usual means of controlling radon emissions. Many tailings impoundments found at other mills are true ponds that can hold water. These ponds are created by placing an earthen dam across a narrow valley or dry stream bed. With such an impoundment, tailings emissions easily can be controlled by covering the tailings with water, although this can aggravate seepage.¹⁴⁰ Homestake's large tailings pile was built on flat ground, covered 170 acres, and was 85 to 100 feet high.¹⁴¹ The pile was built of tailings sands. Tailings were pumped from the mill to the pile where, building on an earth-filled dike, the coarse sands were hydraulically placed to form a rectangular impoundment.¹⁴² The solution and slimes were allowed to float

¹³⁵ Hinchman, *supra* note 131, at 6.

¹³⁶ Memorandum to Docket File No. 40-8903, from Pete Garcia, Project Manager, NRC Region IV, at 2 (Apr. 17, 1990) (on file with NRC/PDR, ACN. 9005090022).

¹³⁷ See HOMESTAKE R.O.D., *supra* note 127, at 2; *Public Hearings*, *supra* note 130, at 112, 124.

¹³⁸ 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 9-12, 9-13. However, in another 1989 study EPA concluded that radon from the Homestake tailings was not contributing significantly to elevated indoor radon levels found in nearby homes. HOMESTAKE R.O.D., *supra* note 127, at ii, 6-9. Such apparent contradictions are common in assessments of the radon danger.

¹³⁹ Petition, *supra* note 123, at 7, 8.

¹⁴⁰ 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 8-18.

¹⁴¹ Letter from F.R. Craft, *supra* note 134, attach. at 1.

¹⁴² *Id.* See also Memorandum from Raymond Gonzales & Dawn Jacoby, to Docket File No. 40-8903, NRC Region IV, at 2 (May 28, 1992) (on file with NRC/PDR, ACN.

to the center.¹⁴³ Over the years a large hill of tailings was created. The top of this tailings pile contains two basins which hold tailings solution and slimes more than 60 feet deep.¹⁴⁴

Another common way to cut radon emissions uses an interim cover of earth over the tailings.¹⁴⁵ This, however, requires heavy equipment to work on the pile, and the tailings usually must be dry.¹⁴⁶ Placing an interim soil cover over the tailings at Homestake would have meant stopping operations and, essentially, beginning reclamation. Homestake had kept operating throughout the 1980s, *albeit* at a greatly reduced level, and had hopes of resuming full production once the uranium market recovered.¹⁴⁷ The company did not want to close the mill and the NRC showed no inclination to force reclamation despite the unresolved problem of airborne contaminants.¹⁴⁸

C. Groundwater Contamination

Groundwater contamination at Homestake was first documented in 1975 in a study done by the EPA and the state of New Mexico.¹⁴⁹ Some wells used by nearby residents were found to be contaminated. Residents were discouraged from using these wells and were provided with bottled water by Homestake.¹⁵⁰

In 1976, Homestake entered an agreement with New Mexico to install a pumping system that would stop further contamination and would begin cleaning up the contaminated aquifers.¹⁵¹ Although the pumping system started up in the late 1970s, in 1983 the EPA placed the Homestake Mill on the National Priorities List of Superfund sites because of groundwater contamination.¹⁵² When

9206160365).

¹⁴³ *Public Hearings*, *supra* note 130, at 112.

¹⁴⁴ Letter from F.R. Craft, *supra* note 134, attach. at 1.

¹⁴⁵ 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 8-18. Chemical stabilization sprays that form coatings on the dry tailings can control dust, but are not effective in controlling radon-222 since an impermeable cover is not obtained. *Id.* at 8-19.

¹⁴⁶ *See* Petition, *supra* note 123, at 8.

¹⁴⁷ *See id.* at 3, 9-13.

¹⁴⁸ NRC's position changed in the early 1990's. *See infra* text accompanying notes 496-535.

¹⁴⁹ HOMESTAKE R.O.D., *supra* note 127, at 2.

¹⁵⁰ Petition, *supra* note 123, at 15-16.

¹⁵¹ *Id.* at 16; HOMESTAKE R.O.D., *supra* note 127, at 2.

¹⁵² HOMESTAKE R.O.D., *supra* note 127, at 2. EPA chose not to list sites on the National Priority List that were directly licensed by the NRC. At the time of listing, Homestake was licensed by the State of New Mexico under the Agreement State Program. *Joint Hearing*, *supra* note 47, at 262.

elevated selenium levels were discovered in residents' wells, Homestake agreed to construct a pipe system to bring water from the town of Milan to the housing estates on Homestake's southern boundary.¹⁵³ This water hook-up was completed in 1985 at a total cost to Homestake of \$3.4 million.¹⁵⁴ Since receiving town water, nearby residents have shown much less concern over the issue of seepage from the tailings.¹⁵⁵

After operations ceased in 1990, Homestake submitted a reclamation plan that estimated total reclamation costs for the tailings and mill site at almost \$20 million.¹⁵⁶ Of this amount, over \$8 million was for restoring groundwater.¹⁵⁷

The groundwater clean-up effort used wells and pumps for two purposes. First, collection wells were located near the downstream side of the large tailings pile. These collection wells caught seepage as it leaked from the tailings and pumped it back onto the tailings pile.¹⁵⁸ Injection wells served a second purpose. They were located on the downstream, southern property boundary, adjacent to the residential estates. These injection wells pumped fresh water into the top two contaminated aquifers.¹⁵⁹ The fresh water diluted and dispersed contaminants. Fresh-water injection also created a hydrologic barrier, preventing the migration of hazardous constituents towards the housing estates which lay beyond the wells.¹⁶⁰

An additional cleansing effect occurred when the wells operated in tandem. When the collection wells next to the tailings were operating, they created a trough, reversing the normal flow of groundwater.¹⁶¹ With the fresh water injection wells also operating, fresh water was pulled back toward the collection wells, flushing out hazardous constituents and cleaning the aquifer.¹⁶²

¹⁵³ Petition, *supra* note 123, at 19-20.

¹⁵⁴ *Id.*

¹⁵⁵ HOMESTAKE R.O.D., *supra* note 127, at 3.

¹⁵⁶ 1 AK GEOCONSULT, 1 RECLAMATION PLAN: HOMESTAKE MINING CO., tbl. 6 (Jan. 1991) (on file with NRC/PDR, ACN. 9102120391).

¹⁵⁷ 1 *id.*

¹⁵⁸ 1 *id.* at 28.

¹⁵⁹ Letter from Roy E. Williams, Williams & Associates (hydrogeology), to Tom Olson, Uranium Recovery Field Office, NRC, Denver, Colo. 1, 2 (Apr. 13, 1987) (on file with NRC/PDR, ACN. 8707020287). The fresh water being injected came from deep wells, drilled into a third uncontaminated deeper aquifer, which is a prolific producer of groundwater. *Id.*

¹⁶⁰ 1 AK GEOCONSULT, *supra* note 156, at 28.

¹⁶¹ 1 *id.*

¹⁶² 1 *id.* The groundwater clean-up system also includes over 400 monitor wells that are regularly sampled for constituents. Petition, *supra* note 123, at 18.

This groundwater clean-up system has been continually refined since it was developed in the 1970s and 1980s.¹⁶³ It has also produced results. An NRC assessment in the early 1990s noted that much of the contamination beyond the Homestake property boundary had been cleaned up, "[a]lthough some isolated occurrences of contaminated water exist. . . ."¹⁶⁴

When the NRC took over regulation of Homestake from New Mexico in 1986, it found only one major problem with the groundwater restoration effort. Hazardous constituents were being recycled. Collected seepage was pumped back onto the tailings pile at an average rate of 300 gallons per minute (gpm)¹⁶⁵ where it could leak out again. Construction of a 24 acre synthetically lined evaporation pond in late 1990 resolved this major problem.¹⁶⁶ The collection wells now return seepage to this lined pond. Once deposited in the pond, evaporation is increased by sprinklers that spray or mist the liquids.¹⁶⁷

A misting sprinkler also has been installed on the larger tailings pile to speed up evaporation and the drying of the tailings.¹⁶⁸ After drying, the tailings will be reshaped to ensure good drainage and then will be permanently covered with dirt and rock. The cover will keep out water and protect the tailings from future wetting which could leach contaminants into the groundwater. The cover will also greatly diminish radon emanating from the tailings pile.

Water quality for the first year in which the evaporation pond was used showed "few changes in constituent concentrations."¹⁶⁹ However, the NRC Project Manager did expect progress and noted that, from a longer term perspective, data from 1982 to 1991 shows "a slow response time to changes in water quality rather than no response."¹⁷⁰ Homestake is among a minority of companies that

¹⁶³ As Homestake notes, "[t]he system is a dynamic system, and the number and location of wells and their respective pumping rates are adjusted as needed to maximize their effectiveness." Petition, *supra* note 123, at 19.

¹⁶⁴ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-8903, at 1 (Mar. 8, 1991) (on file with NRC/PDR, ACN. 9103190273).

¹⁶⁵ Letter from Roy E. Williams, *supra* note 159, at 2.

¹⁶⁶ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-8903, at 2 (May 11, 1992) (on file with NRC/PDR, ACN. 9206040168). The memorandum also notes that Homestake's program now conforms to federal regulations which require that hazardous constituents be removed from the groundwater. *Id.*

¹⁶⁷ *Id.*

¹⁶⁸ *Id.*

¹⁶⁹ *Id.* at 3.

¹⁷⁰ *Id.* In 1994 Homestake reported that site compliance standards had been met for

have made a serious long term effort to resolve groundwater contamination. Even so, when asked for a firm reclamation schedule for the NRC license, Homestake gave 2010 as their projected date for completing groundwater corrective actions.¹⁷¹ NRC's analysis agrees that this date is reasonable.¹⁷² The fact that successful groundwater restoration efforts could take more than 30 years indicates how difficult groundwater clean-up can be.

D. Future Danger From Floods

The Homestake tailings piles are located on the floodplains of San Mateo Creek and Lobo Canyon which have over 300 square miles of upstream watershed.¹⁷³ In a reclamation plan submitted in January 1991, Homestake admitted that long term flood dangers in this location meant they could not satisfy all the federal criteria for reclaiming tailings in place.¹⁷⁴ Nevertheless, NRC did not press for the more expensive option of moving the tailings.¹⁷⁵ Homestake will construct a levee on the east side of the large tailings pile to divert flood flows from Lobo Canyon.¹⁷⁶ Additional flood and erosion protection will come from covering surfaces and out slopes of the two piles with rock (riprap).¹⁷⁷

V. CASE 2: UNITED NUCLEAR CORPORATION'S CHURCH ROCK MILL, NEW MEXICO

A. Introduction

United Nuclear Corporation's (UNC) mill provides an interesting contrast to Homestake. It was built some 20 years after

four constituents: chromium, thorium-230 and radium-226 and 228. The company requested that these be removed from the groundwater corrective action plan. According to Homestake, three main hazardous constituents remain significant at the site: selenium, uranium, and molybdenum. Letter from F.R. Craft, Homestake Mining Company, to NRC, Division of Waste Management, attach. at 3 (July 26, 1994) (on file with NRC/PDR, ACN. 9408040220).

¹⁷¹ Reclamation Schedules, 57 Fed. Reg. 20,716 (1992).

¹⁷² *Id.*

¹⁷³ Memorandum to Docket File No. 40-8903, *supra* note 142, at 7.

¹⁷⁴ 1 AK GEOCONSULT, *supra* note 156, at 21-22.

¹⁷⁵ In July, 1993, NRC issued a "Finding of No Significant Impact" ("FONSI") concerning the reclamation in-place of the Homestake tailings. Finding of No Significant Impact, 58 Fed. Reg. 39,584 (1993).

¹⁷⁶ Memorandum to Docket File No. 40-8903, *supra* note 142, at 7.

¹⁷⁷ *Id.*

Homestake when the dangers of groundwater pollution from uranium mill tailings were already understood. UNC operated for a much shorter period, and closed eight years before Homestake. Yet in its groundwater clean-up effort, UNC has made less progress than Homestake.¹⁷⁸ UNC is also less clear on what future actions are necessary to restore groundwater.

The UNC mill is located in McKinley County, New Mexico, 17 miles northeast of Gallup and one mile south of the Navajo Indian Reservation.¹⁷⁹ In 1990, there were 26 rural Navajo residences within a two mile radius of the mill.¹⁸⁰

UNC is a subsidiary of UNC Inc. By the early 1990s, the parent company had largely left the energy field to deal with products and services in the aviation industry.¹⁸¹ The Church Rock mill was constructed in 1977 to process ore from several underground uranium mines already operating in the vicinity.¹⁸² The mill was built in an alluvial valley known as Pipeline Arroyo, which contains an ephemeral channel flowing between the mill and the tailings pond. The arroyo joins the Puerco River about 2.5 miles downstream from the mill. This river is also dry much of the year.¹⁸³ Up until the mid-1980s, treated water from de-watering of nearby underground uranium mines flowed through the arroyo to the river.¹⁸⁴

During its brief operation, the Church Rock mill produced approximately 3.6 million metric tons of tailings,¹⁸⁵ less than one-fifth of the tailings found at Homestake. The tailings were contained in a large 100 acre unlined pond. The pond was created by a clay core dike constructed along one side of the canyon wall.¹⁸⁶ Internal

¹⁷⁸ See *infra* notes 202-212 and accompanying text.

¹⁷⁹ William Rowe, *Region 6 Involvement in New Mexico: Uranium Mills and Mines*, in EPA WORKSHOP ON RADIOACTIVELY CONTAMINATED SITES 26 (Air and Radiation, U.S. Envtl. Protection Agency, March 1990).

¹⁸⁰ Memorandum from Dana C. Ward, Project Manager, NRC Region IV to Docket File No. 40-8907, (June 13, 1990) (on file with NRC/PDR, ACN. 9007160149).

¹⁸¹ Harlan S. Byrne, *UNC Inc.: Former United Nuclear Finally Finds a Profitable Home*, BARRONS, Dec. 3, 1990, at 48-49.

¹⁸² Rowe, *supra* note 179, at 26.

¹⁸³ The drainage area of Pipeline Arroyo upstream of the disposal area is about 17 square miles. Memorandum from Raymond O. Gonzales et al., Project Manager, NRC Region IV to Docket File No. 40-8907 at 9 (Feb. 5, 1991) (on file with NRC/PDR, ACN. 9102120409).

¹⁸⁴ OFFICE OF EMERGENCY & REMEDIAL RESPONSE, U.S. ENVTL. PROTECTION AGENCY, SUPERFUND RECORD OF DECISION: UNITED NUCLEAR, NM at 11 (Sept. 1988) [hereinafter UNITED NUCLEAR R.O.D.].

¹⁸⁵ *Joint Hearing*, *supra* note 47, at 197.

¹⁸⁶ Letter from Harry Pettengill, NRC Region IV, to UNC Inc. app. B at 11 (Dec. 12, 1986) (on file with NRC/PDR, ACN. 8612190178); EPA ASSESSMENT OF URANIUM

dikes created three separate cells.¹⁸⁷

Two years after beginning operations, the mill received national notoriety when part of the embankment gave way in the southern cell of the tailings pond. Representative Morris Udall explained the consequences of this spill when he opened Congressional Hearings on the matter in 1979.

On July 16 of this year a uranium mill tailings impoundment dam failed, releasing 93 million gallons of contaminated liquid and 1,100 tons of hazardous solid waste into an arroyo near Church Rock, New Mexico. The radioactive and chemically dangerous materials were carried to the Rio Puerco, through Navajo Indian grazing lands near the City of Gallup, New Mexico, and about 20 miles into the State of Arizona, leaving contaminated residue over a distance of close to 100 miles.¹⁸⁸

Another commentator noted that "except for the bomb tests, Church Rock was probably the biggest single release of radioactive poisons on American soil."¹⁸⁹

B. Groundwater Contamination

The tailings embankment was repaired and operations resumed in the fall of 1979. Soon after, the State of New Mexico announced that extensive groundwater contamination had been found independent of the spill.¹⁹⁰ UNC was ordered by the state to develop a discharge plan to control contaminated seepage from its tailings pond.¹⁹¹ In 1981, UNC installed collection wells to catch seepage and pump it back to the tailings pond.¹⁹² While this effort slowed the spread of pollution,¹⁹³ UNC never complied with the state's

MILL TAILING PILES at 4 (Oct. 1991) (on file with EPA Air Docket, Docket No. A-91-67).

¹⁸⁷ Memorandum to Docket File No. 40-8907, *supra* note 183, at 2.

¹⁸⁸ *Mill Tailings Dam Break at Church Rock, New Mexico: Oversight Hearing Before the Subcomm. on Energy and the Environ. of the House Comm. on Interior and Insular Affairs*, 96th Cong., 1st Sess. 1 (1979).

¹⁸⁹ HARVEY WASSERMAN & NORMAN SOLOMON, KILLING OUR OWN: THE DISASTER OF AMERICA'S EXPERIENCE WITH ATOMIC RADIATION 178 (1982).

¹⁹⁰ Memorandum from Michael Brown, Radiation Protection Bureau, Environ. Improvement Division, New Mexico, to Denise Fort, Director E.I.D. 2 (Dec 16, 1986) (on file with NRC/PDR, ACN. 8701160031).

¹⁹¹ *Id.*

¹⁹² UNITED NUCLEAR R.O.D., *supra* note 184, at 4.

¹⁹³ David Staats, *Land Swap Slows Cleanup*, ALBUQUERQUE J., May 11, 1986, at C1.

request for a formal plan to deal with groundwater contamination.¹⁹⁴

Once milling stopped in 1982, New Mexico also failed to get UNC to begin reclamation. State law required reclamation to begin within a year after the end of tailings deposition.¹⁹⁵ Other mining companies were granted extensions, but UNC's request was refused.¹⁹⁶ The state cited thorium-230 leaking into groundwater from the UNC tailings pond as one reason for the refusal.¹⁹⁷

In 1983, EPA placed the UNC Church Rock mill on the National Priorities List of Superfund sites.¹⁹⁸ The EPA justified this by reference to offsite migration of radionuclides and chemical constituents into groundwater, surface water, and air.¹⁹⁹

UNC submitted a "conceptual" reclamation plan to New Mexico in late 1984, but the plan ignored federal requirements which the company argued were inapplicable in New Mexico.²⁰⁰ Little progress was made on a formal reclamation plan before New Mexico returned responsibility for licensing uranium mills to the federal government in 1986.²⁰¹

In 1988, the EPA released a study of groundwater contamination that confirmed observations made by the state of New Mexico some nine years earlier. "The tailings ponds are a source of contaminants to all aquifers at the site. Seepage of tailing liquids has entered the alluvial system from the three tailings cells to varying degrees. . . . Where the alluvium is absent, tailings seepage has also entered the bedrock aquifers. . . ."²⁰²

A new effort to deal with this contamination was finally launched in 1988, over UNC's protests. UNC was threatened with an Administrative Order unless it voluntarily implemented its reclamation plan.²⁰³ This reclamation plan called for the construction of

¹⁹⁴ Memorandum from Michael Brown, *supra* note 190, at 2.

¹⁹⁵ *Id.* at 1.

¹⁹⁶ Staats, *supra* note 193, at C3.

¹⁹⁷ *Id.* See also Memorandum from Michael Brown, *supra* note 190, at 2.

¹⁹⁸ Rowe, *supra* note 179, at 26.

¹⁹⁹ UNITED NUCLEAR R.O.D., *supra* note 184, at 4. See *supra* note 152.

²⁰⁰ Memorandum from Michael Brown, *supra* note 190, at 1. See generally Montange, *supra* note 42, at 344-48 (on the attempt by New Mexican uranium producers, Senator Domenici and others to resist imposition of NRC regulations on New Mexico).

²⁰¹ Memorandum from Michael Brown, *supra* note 190, at 1.

²⁰² UNITED NUCLEAR R.O.D., *supra* note 184, at 11.

²⁰³ Letter from Juan Velasquez, President, United Nuclear Corporation, to Raymond Hall, Director, Uranium Recovery Field Office, NRC, Denver 1, (Dec. 4, 1990) (on file with NRC/PDR, ACN. 9101030196). UNC feared "duplicate work, wasted effort and the

two five-acre synthetically lined evaporation ponds to hold water and contaminants recovered from the aquifer.²⁰⁴ Previously, collected seepage was pumped into a leaking unlined pit in the central tailings cell.²⁰⁵ UNC also was required to install additional pumps to collect contaminated water. This brought groundwater clean-up costs to around \$3 million.²⁰⁶

Results of these efforts have been unpromising. In 1995, EPA noted that concentrations of nitrates, sulfates, and total dissolved solids in the alluvium aquifer "[had] changed very little in the last four plus years. . . ."²⁰⁷ Wells to the north of the impoundment were removing significant amounts of contamination.²⁰⁸ However, in the groundwater under the central tailings cell (Zone One) which had served as the collection point for returned seepage, there were serious problems of water quantity and quality.²⁰⁹ Pumps had nothing to pump. This situation is common when there is a minimal amount of recharge to the groundwater. After the existing water is pumped out, individual pockets of contaminated water remain, separated from each other by air and solid particles.²¹⁰ The NRC had no suggestions for resolving the problem. In 1992, they noted that "the poor response to pumping in Zone [One] may indicate that no

waste of money" if they were forced to begin work before NRC had approved a final reclamation plan, and then later requirements were changed. *Id.* at 2. UNC also objected to having to clean up contaminated groundwater from a site which they argued contained no groundwater until nearby mines began discharging water in the late 1960s. Letter from Juan Velasquez, UNC, to Michael Burkhardt, Director, New Mexico Environmental Improvement Division 3 (July 13, 1987) (on file with NRC/PDR, ACN. 8707310005). *See also infra* note 253 and accompanying text.

²⁰⁴ Canonie Environmental, Ground Water Corrective Action, Church Rock Site 6, 7 (Dec. 1990) (on file with NRC, PDR, ACN. 9101290361).

²⁰⁵ Letter from Harry Pettengill, *supra* note 186, app. B at 11; UNITED NUCLEAR R.O.D., *supra* note 184, at 11.

²⁰⁶ Memorandum to Docket File No. 40-8907, *supra* note 183, at 21.

²⁰⁷ Letter from S.K. Ghose, Superfund Enforcement, EPA, to Julie Curtiss, Navajo Superfund Program 1 (Mar. 13, 1995) (on file with NRC/PDR, ACN. 9503230243). *See also* Letter from Kent Bostick, Jacobs Engineering Group, to Shawn Ghose, EPA 3 (Apr. 12, 1995) (on file with NRC/PDR, ACN. 9505150159).

²⁰⁸ Latif Hamdan, Technical Reviewer, NRC, Technical Evaluation Report, UNC at 3 (Oct. 12, 1994) (on file with NRC/PDR, DKT. 40-8903).

²⁰⁹ Memorandum from Gary Konwinski, Project Manager, NRC Region IV to Docket File No. 40-8907, at 2, 3, 6 (Mar. 4, 1992) (on file with NRC/PDR, ACN. 9203110337).

²¹⁰ *See, e.g.,* Fredric Hoffman, *Ground-Water Remediation Using "Smart Pump and Treat"*, GROUND WATER, Jan.-Feb. 1993, at 98, 100; Clinton W. Hall, *Practical Limits to Pump-and-Treat Technology for Aquifer Remediation*, HAZARDOUS MATERIALS TECH. CENTER, July 1988, at 3.

further action is feasible.”²¹¹ In late 1994, the NRC suggested that UNC might want to submit an application for Alternate Concentration Limits for both the alluvium and the contaminated aquifer under the central tailings cell.²¹²

C. Alternate Concentration Limits

UNC proposed an unrealistic date of December 1995, for completion of groundwater clean-up. Surprisingly, NRC accepted this date and published it in the Federal Register.²¹³ Groundwater remediation could have been completed by this date only if the NRC agreed to relax clean-up standards UNC currently must meet. Federal regulations do allow applications for such Alternate Concentration Limits.²¹⁴ If granted, these alternate limits ease background standards for specific constituents. However, conditions for granting these alternate standards appear to be quite stringent. The applicant must show that past efforts have reduced contaminants “as low as reasonably achievable” considering “practicable corrective actions” available.²¹⁵ The company must also show that the higher level of contaminants remaining after clean-up “will not pose a substantial present or potential hazard to human health or the environment. . . .”²¹⁶ In deciding whether an applicant has met these conditions, NRC must consider, among other factors, current and future use of groundwater in the area and the potential for migration of contaminated groundwater.²¹⁷

Not surprisingly, many mills are interested in obtaining Alternate Concentration Limits.²¹⁸ As of the mid-1990s, the NRC was

²¹¹ Memorandum to Docket File No. 40-8907, *supra* note 209, at 6.

²¹² Hamdan, *supra* note 208, at 3-4.

²¹³ Reclamation Schedules, UNC Church Rock Mill, 57 Fed. Reg. 24,512, 24,513 (1992).

²¹⁴ 10 C.F.R. § 40, app. A, criterion 5B(6) (1994). *See also* Uranium Recovery Branch, Division of Low Level Waste and Decommissioning, NRC, Draft Final Staff Technical Position, Alternate Concentration Limits for Title II Uranium Mills (Feb. 1994) (on file with Uranium Recovery Branch, NRC).

²¹⁵ 10 C.F.R. § 40, app. A, criterion 5B(6) (1994).

²¹⁶ *Id.*

²¹⁷ *Id.*

²¹⁸ As of Dec. 1994, the NRC had received formal applications for Alternate Concentration Limits from ARCO's Bluewater Uranium mill and Quivira's Ambrosia Lake mill in New Mexico; the Atlas Corp. mill in Moab, Utah; and, the American Nuclear Corp. mill in Wyoming. The application for the Western Nuclear mill in Wyoming had been returned as incomplete. An application for UNC's Church Rock mill was expected in 1995. Telephone Interview with official, Uranium Recovery Branch, NRC, in

still working on final guidelines, and had not granted any applications.²¹⁹ Although the NRC had suggested that UNC submit an application for Alternate Concentration Limits, in 1995 NRC refused UNC's request to shut down most of its extraction pumps in anticipation of an Alternate Concentration Limit application submittal.²²⁰

D. Future Danger from Floods

As with the case at Homestake, the tailings in the Pipeline Arroyo at Church Rock will be reclaimed in place. Engineering solutions will be used to overcome site deficiencies.²²¹ The primary site deficiency is that the tailings are in an arroyo susceptible to floods. A poignant forewarning of what might happen if a flood ever did breach the tailings cover was provided by the infamous Church Rock tailings spill of 1979.

VI. CASE 3: QUIVIRA (RIO ALGOM) MINING COMPANY'S AMBROSIA LAKE MILL, NEW MEXICO

A. Introduction

The Quivira case is most noteworthy for its groundwater contamination problem. As with Homestake, this case shows just how difficult groundwater restoration can be. This is true despite Quivira's long term and innovative efforts to control seepage from tailings.

The Ambrosia Lake mill is owned by Quivira Mining Company, a wholly-owned subsidiary of Rio Algom Mining Corporation. Rio Algom purchased the Quivira Mining Company from Kerr-McGee Nuclear Corporation in 1989.²²² The mill is in a remote area 20 miles north of Grants, New Mexico. The Ambrosia Lake mill is built on a flood plain, as are the Homestake and UNC mills.

Rockville, Maryland (Dec. 1994) (notes on file with author).

²¹⁹ *Id.*

²²⁰ Hamdan, *supra* note 208, at 1, 3.

²²¹ Memorandum from Raymond Gonzales et al. to Docket File No. 40-8907, at 3 (Mar. 21, 1991) (on file with NRC/PDR, ACN. 9104040055). One of these engineering solutions is a rock-filled trench (a buried jetty) across the arroyo valley. This will reinforce a bedrock outcrop next to the tailings pile and help prevent headcutting upstream. *Id.* at 3, 11.

²²² Memorandum from Dawn Jacoby et al., Project Managers, NRC Region IV to Docket File No. 40-8905, at 2 (Sept. 24, 1990) (on file with NRC/PDR, ACN. 9010150003).

The tailings impoundments lie within the drainage basin of Arroyo del Puerto, an intermittent stream which flows along the east boundary of the site.²²³ As in the previous two cases, the NRC has decided that the Quivira tailings piles can be reclaimed in place.²²⁴ The valley is about one mile wide at the mill site. With this width it is estimated that the probable maximum flood would not damage the reclaimed tailings.²²⁵

The tailings impoundments at Quivira were constructed like those at Homestake. Built on flat ground and above grade, the unlined impoundment was formed from tailings sands.²²⁶ Usually tailings liquid was pumped from the impoundment into a series of evaporation ponds. Initially, these unlined ponds leaked.²²⁷ By the late 1980s, Quivira's tailings area exceeded even that of Homestake's. Quivira's largest pile was 247 acres.²²⁸ The embankment containing the tailings was from 25 to 90 feet high, and held 30 million tons of tailings.²²⁹ A contiguous smaller pile held three million tons of tailings covering 100 acres.²³⁰

The Ambrosia Lake mill began operations in 1958, processing ore from nearby mines, some owned by Quivira.²³¹ The facility went on standby in January 1985 due to the depressed uranium market.²³² However, the company has continued some small scale operations. Uranium is extracted from underground mines using chemically fortified mine waters.²³³ The mill also is licensed to process and dispose of byproduct material from the Sequoyah Fuels uranium hexafluoride conversion facility in Gore, Oklahoma.²³⁴

²²³ *Id.* at 10-11. The drainage area of Arroyo del Puerto above the mill site is about 58 square miles. A second drainage area of approximately 3.7 square miles is located just west of the mill site. Runoff from this area is diverted around the tailings area by a diversion ditch. *Id.* at 11.

²²⁴ *Id.* at 25-27.

²²⁵ *Id.* at 14.

²²⁶ Quivira Mining Co., Proposed Alternative Concentration Limits for the Alluvial Unit 24, 26 (June 18, 1991) (on file with NRC/PDR, ACN. 9107250214) [hereinafter Proposed ACLs].

²²⁷ *Id.* at 11-12.

²²⁸ Memorandum to Docket File No. 40-8905, *supra* note 222, at 2.

²²⁹ *Id.*

²³⁰ *Id.*

²³¹ *Id.*

²³² *Public Hearings*, *supra* note 130, at 48 (testimony of Bill Ferdinand representing Rio Algom).

²³³ Letter from Ramon Hall, Director, Uranium Recovery Field Office, NRC Region IV, to Bill Ferdinand, Quivira Mining Co., enclosure 1 at 3 (Apr. 12, 1991) (on file with NRC/PDR, ACN. 9104170015).

²³⁴ U.S. NRC Materials License, Quivira Mining Co. 5 (Sept. 24, 1990) (on file

B. Groundwater Contamination

In 1983, Quivira signed an Assurance of Discontinuance agreement with the State of New Mexico.²³⁵ Quivira agreed to address the problem of contaminants leaking from unlined tailings piles and evaporation ponds.²³⁶ The key element in Quivira's plan to combat groundwater contamination was a 6,200-foot-long "interceptor trench" built on the east side of the largest pile.²³⁷ The company also agreed to quit pumping tailings solution into unlined evaporation ponds.²³⁸ However, Quivira continued using its two tailings piles, even though they were unlined and leaked.²³⁹

The new interceptor trench intercepted seepage from the largest tailings pond. The trench also created a hydrologic sink, causing contamination that had already moved beyond the trench to flow back toward the trench.²⁴⁰ The effort to clean up the alluvial aquifer was greatly aided by a source of re-charge water available on the site. Treated water from mine de-watering and mill operations was pumped into a channel that ran along the northern and eastern boundary of the mill.²⁴¹ Water in this channel percolated into the ground as it passed through the property and flushed contaminants back toward the trench.²⁴² Water and contaminants caught by the interceptor trench were then pumped to new lined ponds for evaporation.²⁴³

Quivira's tailings had also polluted two aquifers underlying the alluvium, the Tres Hermanos B and Dakota formations.²⁴⁴ Quivira argued that these aquifers would be cleaned up in the normal pro-

with NRC/PDR, ACN. 9010120084). *See also* Letter from Bill Ferdinand, Quivira Mining Co., to Gary Konwinski, NRC, Uranium Recovery Field Office, Denver, attach. at 2 (Dec. 16, 1992) (on file with NRC/PDR, ACN. 9302180173).

²³⁵ Proposed ACLs, *supra* note 226, at 12.

²³⁶ *Id.*

²³⁷ *Id.* *See* Quivira Mining Co., Corrective Action Programs, Ambrosia Lake Facility 2-3 (Sept. 25, 1989) (on file with NRC/PDR, ACN. 8912070218) [hereinafter Quivira Mining Co.].

²³⁸ Proposed ACLs, *supra* note 226, at 12.

²³⁹ *Id.* at 13-14.

²⁴⁰ Quivira Mining Co., *supra* note 237, at 2-3; *see also* Proposed ACLs, *supra* note 226, at 12-13.

²⁴¹ Proposed ACLs, *supra* note 226, at 11-13.

²⁴² *Id.* at 13.

²⁴³ *Id.* at 12-14.

²⁴⁴ Quivira Mining Co., *supra* note 237, at 12, 22; Memorandum for Docket File No. 40-8905, from Cynthia Miller-Corbett, Project Manager, Region IV, NRC 2 (Nov. 16, 1990) (on file with NRC/PDR, ACN. 9011200276).

cess of pumping water from its underground uranium mines. According to Quivira, the pumping would pull contaminated groundwater in these aquifers toward the pumps where it could be removed.²⁴⁵

Quivira went on stand-by in 1985 and, in 1986, the NRC took over licensing the mill from New Mexico.²⁴⁶ In May 1990, a new \$1.1 million plan to deal with groundwater contamination was approved.²⁴⁷ The plan built on past clean-up efforts with one major addition. Quivira committed to begin reclaiming its two unlined tailings piles.²⁴⁸ This meant that the remaining source of groundwater contamination would be eliminated. These piles would be dried and covered, protecting them against any re-wetting that could again leach contaminants into the groundwater. The company also agreed that if milling operations resumed, future tailings would be placed in synthetically lined cells.²⁴⁹ Byproduct material from the Sequoyah Plant in Gore, Oklahoma, would be deposited in a 2.8 acre lined pond built on top of the smaller tailings pile.²⁵⁰

Quivira has tried to contain and clean up contamination since at least 1983. Yet in the early 1990s extensive contamination still existed in both the alluvium and underlying aquifers. Concentrations of most measured contaminants were well above the background standards to which groundwater must be restored.²⁵¹ There are no indications that progress will be more rapid in the 1990s than in the 1980s. The hydro-engineering firm hired by Quivira estimated that successful remediation would not be achieved until the year 2043.²⁵² This date is exactly sixty years after Quivira first signed

²⁴⁵ Quivira Mining Co., *supra* note 237, at 13, 24-25; Memorandum for Docket File No. 40-8905, *supra* note 244, at 5.

²⁴⁶ *Public Hearings*, *supra* note 130, at 48 (testimony of Bill Ferdinand representing Rio Algom). See also *supra* notes 128, 129 and accompanying text.

²⁴⁷ Letter from Peter Luthiger, Quivira Mining Co., to Ramon Hall, NRC, Uranium Recovery Field Office, Denver, attach. at 1 (Aug. 1, 1991) (on file with NRC/PDR, ACN. 9109100269); Memorandum for Docket File No. 40-8905, *supra* note 222, at 25.

²⁴⁸ Quivira Mining Co., *supra* note 237, at 13.

²⁴⁹ *Id.*; Ambrosia Lake Mill, Quivira Mining Co., in EPA ASSESSMENT OF URANIUM MILL TAILING PILES at 1, 2 (Oct. 1991) (on file with EPA Air Docket, Docket No. A-91-67).

²⁵⁰ *Public Hearings*, *supra* note 130, at 58-59 (testimony of Bill Ferdinand representing Rio Algom); Letter from Bill Ferdinand, *supra* note 234, attach. at 2-4. A dewatering and interceptor trench, similar to the one for the larger tailings pond, had already been built in 1989 to catch seepage from the small tailings pile. Letter from Peter Luthiger, *supra* note 247, attach. at 2.

²⁵¹ Memorandum for Docket File No. 40-8905, *supra* note 244, at 1-4.

²⁵² Letter from Bill Ferdinand, Quivira Mining Co., to Ramon Hall, Director, NRC Uranium Recovery Field Office, Denver, Colo. attach. at 2-3 (Nov. 22, 1991) (on file

an agreement with the state of New Mexico to deal with groundwater contamination.

Quivira's main hope for more rapid and less costly groundwater clean-up lies with the NRC agreeing to their application for Alternate Concentration Limits. Quivira's request for Alternate Concentration Limits repeats arguments made by UNC against the clean-up standards it must meet. Both companies contend that the alluvium underlying their mill sites was dry before mining began in the late 1950s. They argue that water pumped from underground mines and leaking tailings piles created the alluvium aquifer. Once this human made re-charge ends, they reason, the aquifer will dissipate naturally and no longer support any use.²⁵³

The State of New Mexico has questioned this argument. "[S]ite remediation may be required regardless if water was, or was not present in these sediments prior to mining operations. The groundwater now there is contaminated and could reasonable [sic] be expected to reach aquifers beneath. . . ."²⁵⁴

VII. CASE 4: WESTERN NUCLEAR INC. (PHELPS DODGE) SPLIT ROCK MILL, WYOMING

A. Introduction

Western Nuclear Inc.'s Split Rock uranium mill provides another example of serious groundwater problems that are as yet unresolved. The unlined tailings pond at Western Nuclear was constructed on alluvial sands above two aquifers.²⁵⁵ Over the years these aquifers were extensively polluted.²⁵⁶ In a 1980 study for the renewal of Western Nuclear's license, the NRC argued that this pollution problem would resolve itself naturally.²⁵⁷ This view changed

with NRC/PDR, ACN. 9112270189). *See also* Quivira Mining Co., Reclamation Schedules, 57 Fed. Reg. 49,103, 49,104 (1992).

²⁵³ Proposed ACLs, *supra* note 226, at 4, 6-12. *See also* Letter from Juan Velasquez, *supra* note 203, at 3.

²⁵⁴ Letter from Richard Ohrbom, Water Resource Specialist, New Mexico Health and Environment Dept., to Bill Ferdinand, Quivira Mining Co. 1 (Feb. 20, 1991) (on file with NRC/PDR, ACN. 9103140108).

²⁵⁵ MINERAL RESOURCES WASTE MANAGEMENT TEAM (COLLEGE OF MINES AND EARTH RESOURCES, UNIV. OF IDAHO), OVERVIEW OF GROUND WATER CONTAMINATION ASSOCIATED WITH SIX OPERATING URANIUM MILLS IN THE UNITED STATES 54, 58-59 (Dec. 30, 1980) (on file with EPA Air Docket, Docket No. A-82-26) [hereinafter GROUND WATER CONTAMINATION].

²⁵⁶ *See infra* notes 257-283 and accompanying text.

²⁵⁷ OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, U.S. NUC. REG.

by the late 1980s. NRC is requiring Western Nuclear to remove contaminants from the aquifer.²⁵⁸ However, there is still reason to doubt NRC's commitment to groundwater restoration.²⁵⁹

The Split Rock mill also had a severe problem with wind blown tailings. The problem was exacerbated by high wind speeds and by blowing sand which scoured the tailings.²⁶⁰ At most of Wyoming's uranium mills this would not have been a threat to public health because the mills are so isolated. However, Western Nuclear had developed a company town, Jeffrey City, two miles from the mill.²⁶¹ In the 1970s there were over 2,000 residents in the town.²⁶² There were still over 100 by the mid-1990s.²⁶³ During the 1980s, Western Nuclear installed over 50,000 feet of porous wind fencing to protect the tailings.²⁶⁴ Nonetheless, a 1987 radiological survey identified 170 acres on which wind blown tailings had accumulated.²⁶⁵ These tailings deposits ranged in depth from six inches to four feet.²⁶⁶ Finally, some ten years after milling had stopped, the problem of blowing tailings was resolved when an interim soil cover was placed over the tailings.²⁶⁷ There are also questions about the long-term invulnerability of Western Nuclear's tailings. Despite early objections by the EPA and the State of Wyoming,²⁶⁸ the NRC has decided that the tailings will be reclaimed where they stand, at the end of a natural drainage, a mile south of the Sweetwater River.²⁶⁹

COMM., FINAL ENVIRONMENTAL STATEMENT: SPLIT ROCK URANIUM MILL 4-3, 4-5, 8-1 (Feb. 1980) [hereinafter SPLIT ROCK E.S.].

²⁵⁸ See *infra* notes 285-291 and accompanying text.

²⁵⁹ See *infra* text accompanying notes 301-307.

²⁶⁰ Western Nuclear, Inc., Annual Report 1988 at 40 (Aug. 16, 1987 to May 31, 1988) (on file with archives, Wyoming Department of Environmental Quality [hereinafter Wyo. DEQ]) [hereinafter Western Nuclear, Inc.].

²⁶¹ See generally Amundson, *supra* note 44 (writing on the history of the town of Jeffrey City).

²⁶² SPLIT ROCK E.S., *supra* note 257, at 2-7. Amundson estimates that the population of Jeffrey City grew from 2,500 in 1977 to over 4,000 by 1980. Amundson, *supra* note 44, at 484, 495.

²⁶³ Norma Williamson, *Company Eyes Jeffrey City Renewal: Effort Planned to Sell, Rent Vacant Homes*, CASPER STAR-TRIBUNE, Mar. 5, 1995, at B1.

²⁶⁴ Western Nuclear, Inc., *supra* note 260, at 42.

²⁶⁵ Split Rock Uranium Mill, in EPA ASSESSMENT OF URANIUM MILL TAILING PILES at 2 (Oct. 1991) (on file with EPA Air Docket, Docket No. A-9-67).

²⁶⁶ Western Nuclear, Inc., Split Rock Mill Tailings Regrading Report 1990 at 10 (Feb. 1991) (on file with NRC/PDR, Docket No. 40-1162).

²⁶⁷ *Id.* at 11.

²⁶⁸ SPLIT ROCK E.S., *supra* note 257, at A-15, A-44.

²⁶⁹ Finding of No Significant Impact, 58 Fed. Reg. 33,285 (1993).

Western Nuclear Inc. is a subsidiary of Phelps Dodge Inc., a major copper mining and manufacturing company.²⁷⁰ The Split Rock mill, the first built in Wyoming, was constructed in 1957.²⁷¹ The mill is located between the Gas Hills and Crook's Gap uranium mining districts in south central Wyoming. It served uranium mines in both areas.²⁷² The tailings impoundment was created by damming part of a natural drainage.²⁷³ In April 1977, 33 feet of the dam was breached. This released about two million gallons of tailings solution, all of which was contained inside the mill boundaries.²⁷⁴ The dam was repaired and a new compacted tailings dam constructed upstream from the existing dam.²⁷⁵ Today, the combined disposal area covers 180 acres and contains approximately 7.7 million tons of tailings.²⁷⁶

B. Groundwater Contamination

In the context of the mid-1950s, Western Nuclear's system for disposing of tailings solution at its Split Rock mill was perfect. "The idea in the old days was simply to get rid of it."²⁷⁷ The unlined tailings pond was built over two deep paleo stream valleys that had filled with sediment, the upper layer of which was sand and alluvium.²⁷⁸ Tailings liquid in the unlined pond simply leaked through the sands into the aquifers beneath and was carried toward the Sweetwater River a mile to the north.²⁷⁹ In 1980, when the mill was still operating, the NRC estimated that contaminated water was leaking from the tailings at a rate of about 1,200 gallons per minute.²⁸⁰

²⁷⁰ THOMAS J. HILLIARD, MINING REPORT CARD FOR PHELPS DODGE CORPORATION 1 (Mineral Policy Center Mining Accountability Project, 1993). See also OFFICE OF RADIATION PROGRAMS, U.S. ENVTL. PROTECTION AGENCY, FINAL RULE FOR RADON-222 EMISSIONS FROM LICENSED URANIUM MILL TAILINGS at 40, 42 (Economic Analysis, Aug. 1986).

²⁷¹ SPLIT ROCK E.S., *supra* note 257, at 1-1. See generally, Amundson, *supra* note 44, at 486-93.

²⁷² SPLIT ROCK E.S., *supra* note 257, at 1-3, 2-25.

²⁷³ *Id.* at 2-13.

²⁷⁴ *Id.* at 3-17, 5-5; Marjane Ambler, *NRC Tailings Control Too Lax, Wyoming Charges*, HIGH COUNTRY NEWS, Dec. 14, 1979, at 10.

²⁷⁵ Split Rock Uranium Mill, *supra* note 265, at 1.

²⁷⁶ *Id.*

²⁷⁷ Interview with official, Div. of Land Quality, Wyoming Dept. of Envtl. Quality, in Cheyenne, Wyo. (Aug. 11, 1988).

²⁷⁸ GROUND WATER CONTAMINATION, *supra* note 255, at 54, 58-59.

²⁷⁹ See *id.* at 54, 55; Interview with official, *supra* note 277; SPLIT ROCK E.S., *supra* note 257, at 4-3.

²⁸⁰ SPLIT ROCK E.S., *supra* note 257, at 4-3, C-2 to C-5.

Over the years, an enormous mound of water formed under the leaking tailings pond.²⁸¹ This mound created a gradient that caused the plume of seepage to migrate down the two aquifer valleys (the Northwest and Southwest Valleys).²⁸² The principal contaminants found in the underlying aquifers are radium-226, thorium-230, lead-210, polonium-210, uranium, and arsenic.²⁸³

Operations ceased in 1981 with the collapse of the uranium market.²⁸⁴ The mill never resumed production, although it remained on stand-by status until 1986. In 1986, Western Nuclear informed the state and the NRC of their intent to reclaim.²⁸⁵ The first reclamation plan they proposed was to shut off the collection pumps so the tailings could dry.²⁸⁶ These pumps had been returning seepage to the tailings pond and, in the process, rewetting the tailings.²⁸⁷ Once dried, the tailings would be covered. Western Nuclear did not plan to resume pumping the aquifer. Instead, the company proposed that natural geochemical and hydrologic processes be allowed to mitigate past groundwater contamination.²⁸⁸ The NRC, which had suggested in 1980 that such a plan might be feasible,²⁸⁹ allowed Western Nuclear to shut off its pumps.²⁹⁰ However, when contamination increased in the aquifers, Western Nuclear was told to develop a plan that would remove contaminants from the aquifers.²⁹¹ This task has proved very difficult.

²⁸¹ See Letter from Stephanie Baker, Western Nuclear, Inc., to Ramon Hall, NRC, Uranium Recovery Field Office, Denver, Colo., attach. at 1 (June 29, 1990) (on file with NRC/PDR, ACN. 9009050146).

²⁸² *Id.*; GROUND WATER CONTAMINATION, *supra* note 255, at 64-70.

²⁸³ GROUND WATER CONTAMINATION, *supra* note 255, at 55.

²⁸⁴ Mark Moxley, Wyo. Dept. of Envtl. Quality Annual Inspection Report, Western Nuclear, Inc. 3 (Sept. 17, 1987) (on file with archives, Wyo. DEQ).

²⁸⁵ *Id.*

²⁸⁶ See Memorandum from Candice Jierree, Project Manager, NRC Region IV, to Docket File No. 40-1162, at 1 (June 16, 1987) (on file with archives, Wyo. DEQ). See also Letter from Terence Kippen, Western Nuclear, Inc., to Edward Hawkins, NRC Region IV, at 3, 4 (Aug. 31, 1989) (on file with NRC/PDR, ACN. 8910050141).

²⁸⁷ See Memorandum from Candice Jierree to Docket File No. 40-1162, *supra* note 286, at 1.

²⁸⁸ See Letter from Terence Kippen to Edward Hawkins, *supra* note 286, at 3-6; letter from Stephanie Baker, Western Nuclear, Inc., to R. Dale Smith, NRC Region IV, at 2 (Apr. 8, 1988) (on file with NRC/PDR, ACN. 8804280290).

²⁸⁹ SPLIT ROCK E.S., *supra* note 257, at 4-3, 4-5, 8-1.

²⁹⁰ Memorandum from Candice Jierree to Docket File No. 40-1162, *supra* note 286, at 1.

²⁹¹ Letter from Terence Kippen to Edward Hawkins, *supra* note 286, at 4, 5. See Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-1162 at 1, 2 (Mar. 21, 1991) (on file with NRC/PDR, ACN. 9104030287).

The principal problems Western Nuclear must deal with in its groundwater restoration effort are too much prior seepage and too much water. In 1990, seepage was flowing from the mound of contaminants underneath the tailings pond at 334 gallons per minute (gpm) in the Northwest Valley aquifer, and 51 gpm in the Southwest Valley aquifer.²⁹² A newly installed pumping system was extracting groundwater from the contaminated aquifers at an average rate of 68 gpm (20 percent of the seepage rate) in the Northwest Valley, and 38 gpm (75 percent of the seepage rate) in the Southwest Valley.²⁹³ The rate of seepage exceeded the rate of collection. In addition, not all of the water pumped from the aquifer was from the plume of contaminants. Some was recharge coming from the Sweetwater River alluvium aquifer.²⁹⁴

Through vigorous pumping some progress has been made in decreasing the mound of seepage underneath the tailings pond.²⁹⁵ Improvements in water quality have been less promising. In 1993, NRC concluded that "there was a slight reduction in hazardous constituent concentrations associated with initial seepage recovery efforts. Following this, hazardous constituent concentrations remain elevated, but have stayed at rather constant levels."²⁹⁶

One definite improvement is that water and seepage collected by the pumps are no longer returned to the tailings pond where the contamination could leak back into the aquifer. This contaminated water now goes to lined storage ponds where it is fed into an enlarged evaporation spray mist system.²⁹⁷ The spray system evaporates up to 66 million gallons of contaminated water a year.²⁹⁸ In

²⁹² Letter from Stephanie Baker to Ramon Hall, *supra* note 281, attach. at 1.

²⁹³ *Id.*

²⁹⁴ *Id.*

²⁹⁵ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-1162, at 2 (Oct. 18, 1990) (on file with NRC/PDR, ACN. 9011050195); Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-1162, at 2 (Feb. 5, 1993) (on file with NRC/PDR, ACN. 9302220427) [hereinafter Memorandum of Feb. 5, 1993].

²⁹⁶ Memorandum of Feb. 5, 1993, *supra* note 295, at 2. See also Letter from Stephanie Baker, Western Nuclear, Inc., to Director, Division of Radiation Safety and Safeguards, NRC Region IV, at 1 (Sept. 9, 1994) (on file with NRC/PDR, ACN. 9409270094); letter from Stephanie Baker, Western Nuclear, Inc., to Joseph Holonich, Chief, NRC High Level Waste and Uranium Recovery Projects Branch 1 (Mar. 1, 1995) (on file with NRC/PDR, ACN. 9503090008).

²⁹⁷ Letter from Stephanie Baker (accompanying Annual Groundwater Corrective Action Program Review), to Ramon Hall, Director, NRC Uranium Recovery Field Office, Denver, Colo., enclosure at 2-3 (Dec. 15, 1992) (on file with NRC/PDR, ACN. 9303110277).

²⁹⁸ Memorandum of Feb. 5, 1993, *supra* note 295, at 1, 2.

winter months, recovered contaminated water is stored in two lined ponds to await summer evaporation.²⁹⁹ By 1991, an interim soil cover also had been placed over the dried and recontoured tailings.³⁰⁰ This cover should prevent further leaching of tailings from melting snow or rain.

There are, however, two factors which raise doubt about the commitment of the NRC and Western Nuclear to long-term groundwater restoration. Western Nuclear has estimated costs for groundwater cleanup at only \$78,600.³⁰¹ These estimates have been accepted by the NRC as the basis for the bond the company must post to assure that groundwater reclamation will be completed.³⁰² This small sum hardly represents a financial guaranty. In New Mexico, the NRC has required bonding levels for groundwater clean-up for Homestake which are over one hundred times as high (\$8 million),³⁰³ for UNC, which are forty times as high (approximately \$2.6 million),³⁰⁴ and for Quivira, which are over twelve times as high (\$1 million).³⁰⁵

Also in 1992, without explanation, the NRC accepted, and published in the Federal Register, December 1994 as Western Nuclear's firm date for completion of its groundwater corrective action program.³⁰⁶ When 1994 arrived, the date was changed to 1996.³⁰⁷ Neither this overly optimistic date for final remediation nor the small surety are indicative of a long-term commitment to groundwater restoration. Yet, Western Nuclear has one of the most severe groundwater contamination problems of the mills studied.

²⁹⁹ Letter from Stephanie Baker to Ramon Hall, *supra* note 297, at 2, 3.

³⁰⁰ Western Nuclear, Inc., *supra* note 266, at 11; Memorandum from Dana Ward, Project Manager, NRC Region IV, to Docket File No. 40-1162, at 2 (Apr. 27, 1992) (on file with NRC/PDR, ACN. 9205120190).

³⁰¹ Western Nuclear, Inc., 1990 GROUND WATER CORRECTIVE ACTION PROGRAM REVIEW at 6, 7 (Oct. 1, 1990) (on file with NRC/PDR, ACN. 9011150075). These estimates did not include costs for pumps and the evaporation system that had already been installed. *Id.*

³⁰² See Memorandum from Paul Michaud, Project Manager, NRC Region IV, to Docket File No. 40-1162 (Annual Surety Review), at 1 (Nov. 29, 1990) (on file with NRC/PDR, ACN. 9012100186).

³⁰³ 1 AK GEOCONSULT, *supra* note 156, tbl. 6.

³⁰⁴ Memorandum from Raymond O. Gonzales et al. to Docket File No. 40-8907, *supra* note 183, at 21.

³⁰⁵ Memorandum from Dawn Jacoby et al. to Docket File No. 40-8905, *supra* note 222, at 25.

³⁰⁶ Western Nuclear, Inc., Reclamation Schedules, 57 Fed. Reg. 27,482 (1992).

³⁰⁷ Notice of Amendment to Change Reclamation Milestone Dates, Western Nuclear, Inc., 59 Fed. Reg. 46,455 (1994).

C. Questions About Flood Dangers

The Split Rock tailings impoundment is one mile from the Sweetwater River.³⁰⁸ This river is an important source of water for agriculture and wildlife in semiarid south central Wyoming. The river eventually joins the North Platte River which then flows through Casper, Wyoming.

The Split Rock tailings are being reclaimed in place and will not be moved away from the river.³⁰⁹ In 1979, during the environmental review for renewal of Western Nuclear's license, EPA argued that the "existing tailings impoundment should be abandoned and replaced by an impoundment constructed and operated in accordance with the disposal requirements for new mills, and should include relocation of existing tailings."³¹⁰ The State of Wyoming noted in its comments that "the alternative of removing tailings to mined-out pits was not adequately considered."³¹¹ The NRC, citing impracticability and costs, rejected both comments and noted that transporting the tailings would involve health and environmental risks.³¹² The NRC also presented data from Western Nuclear that showed "flood waters from the maximum thunderstorm over the Sweetwater River basin would not reach the tailings pond embankment."³¹³ This same study by the company also showed that a maximum precipitation event over the 470-acre drainage area behind the tailings embankment would not overtop the embankment or affect its stability.³¹⁴

VIII. CASE 5: AMERICAN NUCLEAR CORPORATION GAS HILLS URANIUM MILL, WYOMING

A. Introduction

In May 1994, American Nuclear Corporation announced that it

³⁰⁸ SPLIT ROCK E.S., *supra* note 257, at 2-13, 2-14.

³⁰⁹ Finding of No Significant Impact, *supra* note 269, at 33,285.

³¹⁰ SPLIT ROCK E.S., *supra* note 257, at A-15.

³¹¹ *Id.* at A-44.

³¹² *Id.* at 10-1, A-15, A-44.

³¹³ *Id.* at 5-4. See also Memorandum from Raymond Gonzales, Project Manager, NRC Region IV, to Docket File No. 40-1162, at 5-8 (Mar. 25, 1994) (on file with NRC/PDR, ACN. 9404280059).

³¹⁴ SPLIT ROCK E.S., *supra* note 257, at 5-4. See also Memorandum from Raymond Gonzales, Project Manager, NRC Region IV, to Docket File No. 40-1162, *supra* note 313, at 5, 10-12.

was discharging its employees, discontinuing operations immediately, and going out of business.³¹⁵ The company was unable to meet payments on a \$2.3 million mortgage.³¹⁶ The state of Wyoming held the reclamation bond for the site, an arrangement allowed by the NRC.³¹⁷ The bond to guarantee reclamation of the tailings was worth approximately \$3.2 million. Most of the bond was in the form of liquid investments in a trust account.³¹⁸ This bond has now been forfeited.³¹⁹ The state of Wyoming will reclaim the site. There is some question, however, if the bond will fully cover the costs of remaining reclamation work.³²⁰ If the bond is insufficient, federal monies provided by recent legislation to help the uranium industry may make up the difference.³²¹

American Nuclear's mill site is located in the heart of the remote Gas Hills uranium mining district, some 20 miles north of Jeffrey City and 45 miles southeast of Riverton. American Nuclear was one of the independent uranium companies which emerged during Wyoming's first uranium boom in the 1950s.³²² The mill began operation in 1959 as the Federal American Partners' Gas Hills Mill.³²³ American Nuclear was the managing partner, and later became the operating contractor when the mill was leased by the Tennessee Valley Authority (TVA).³²⁴ Mill operations were suspended by TVA in 1981.³²⁵

³¹⁵ Letter from William Salisbury, President, American Nuclear Corp., to William Brown, Regional Counsel, NRC Region IV, at 1, attachment at 1 (May 9, 1994) (on file with NRC/PDR, ACN. 9405250145).

³¹⁶ Letter from William Salisbury, President, American Nuclear Corp., to Director, Office of Enforcement, NRC 4 (May 25, 1994) (on file with NRC/PDR, ACN. 9406100276).

³¹⁷ Letter from Edward Hawkins, NRC Region IV, to Niles Andrus, American Nuclear Corporation 3, 4 (Aug. 11, 1987) (on file with NRC/PDR, ACN. 8708190166).

³¹⁸ Letter from William Salisbury to Director, *supra* note 316, at 2.

³¹⁹ Wyoming Environmental Quality Council, Order for Bond Forfeiture, Docket File No. 2557-94 (Oct. 5, 1994) (on file with NRC/PRD, ACN. 9410280059).

³²⁰ In late 1995 the State of Wyoming estimated reclamation costs at American Nuclear to be between \$5 million and \$6 million, not including cost of cleaning up contaminated groundwater. Chris Tollefson, *Uranium Cleanup Funding Uncertain*, CASPER STAR-TRIBUNE, Sept. 25, 1995, at A4. *See also infra* note 345.

³²¹ *See infra* text accompanying notes 361-370; Tollefson, *supra* note 320, at A4.

³²² Letter from William Salisbury to William Brown, *supra* note 315, attach. at 1.

³²³ 3 FINAL GENERIC E.I.S., *supra* note 73, at T-10.

³²⁴ Memorandum from Mark Moxley, Land Quality, District 2 Supervisor, to Dennis Hemmer, Director, Wyoming DEQ, ANC Bond Forfeiture Recommendation 1 (May 24, 1994) (on file with files Wyo. DEQ).

³²⁵ Federal-American Partners/American Nuclear Corporation, in EPA ASSESSMENT OF URANIUM MILL TAILING PILES at 1 (Oct. 1991) (on file with EPA Air Docket, Docket No. A-91-67); *Western Roundup*, HIGH COUNTRY NEWS, Mar. 6, 1981.

After the mill shut down, TVA sold the mines associated with the property.³²⁶ In 1985 under a contractual agreement with TVA, American Nuclear became the sole owner and assumed all reclamation liability for the mill site.³²⁷ In 1990 Cycle Resources Investment Corporation, a subsidiary of the German corporation NUKEM, purchased approximately 30% of American Nuclear's outstanding company stock.³²⁸

Tailings at American Nuclear were deposited in slurry form in an unlined tailings pond.³²⁹ Liquids from this impoundment were decanted into an unlined evaporation pond.³³⁰ Both of these tailings impoundments were built by placing an earthen dam across a dry drainage.³³¹ The main tailings impoundment holds approximately 6.7 million cubic yards of tailings.³³² The evaporation pond holds approximately 1.3 million cubic yards of tailings.³³³ Together, the two impoundments contain about 5.4 million metric tons of tailings and cover 117 acres.³³⁴

American Nuclear has a long history of seepage from its evaporation ponds.³³⁵ The evaporation pond is underlain by a shallow aquifer composed of recent alluvial deposits and weathered sandstone. There is a deeper aquifer below.³³⁶ A 1980 study of groundwater contamination indicated seepage had migrated into the shallow aquifer and spread 2,000 to 3,000 feet from the evaporation pond.³³⁷ A system of six wells to collect seepage and pump it back into the pond was installed in 1978.³³⁸ However, by 1987, only

³²⁶ Memorandum from Mark Moxley to Dennis Hemmer, *supra* note 324, at 1, 2.

³²⁷ *Id.* at 1. See also Memorandum from Rick Nevin, ICF Incorporated, to Ken Hooks NMSS, Review and Analysis of American Nuclear Corporation Financial Documents 2 (July 12, 1994) (on file with NRC/PDR, ACN. 9407220284).

³²⁸ Memorandum from Rick Nevin to Ken Hooks, *supra* note 327, at 2.

³²⁹ 3 FINAL GENERIC E.I.S., *supra* note 73, at T-10; GROUND WATER CONTAMINATION, *supra* note 255, at 72.

³³⁰ 3 FINAL GENERIC E.I.S., *supra* note 73, at T-10; Federal-American Partners/American Nuclear Corporation, *supra* note 325, at 1.

³³¹ 3 FINAL GENERIC E.I.S., *supra* note 73, at T-10. See Federal-American Partners/American Nuclear Corporation, *supra* note 325, at 1.

³³² Letter from William Salisbury, American Nuclear, to Irwin Dickstein, Region VIII, EPA, Denver 2 (Dec. 20, 1990) (on file with NRC/PDR, ACN. 9101150121).

³³³ *Id.*

³³⁴ *Joint Hearing*, *supra* note 47, at 197; 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 9-10.

³³⁵ See GROUND WATER CONTAMINATION, *supra* note 255, at 72.

³³⁶ *Id.*

³³⁷ *Id.*

³³⁸ AMERICAN NUCLEAR CORPORATION, AMENDMENT APPLICATION 5 (1987) (response to NRC's Aug. 11, 1987 comment letter) (on file with NRC/PDR, DKT. 40-

one well was producing enough water to operate a pump.³³⁹

B. Financial Difficulties and Reclamation Delays

Throughout the late 1980s reclamation proceeded very slowly at American Nuclear Corporation. Although milling stopped in the early 1980s it was not until 1990 that an interim soil cover was placed over both tailings ponds.³⁴⁰ One reason for the delay was that American Nuclear lacked the cash to finance reclamation.³⁴¹ To speed up reclamation, the State of Wyoming, with the approval of the NRC, began to rebate bond money to American Nuclear whenever a particular piece of reclamation work was completed.³⁴² Between 1988 and 1990 a million dollars of the bond money held by the state was returned to American Nuclear.³⁴³ In retrospect, these frequent rebates were probably a poor idea. American Nuclear went out of business in 1994 with considerable reclamation work left undone. Release of a million dollars of bond money did not even produce much reclamation once the interim soil cover was in place. In 1994 the state concluded that "no significant reclamation work has been conducted under this permit since 1990."³⁴⁴

It does not appear that the remaining bond money will cover the costs to the state of reclamation.³⁴⁵ In addition, none of the

4492).

³³⁹ *Id.* at 7.

³⁴⁰ Letter from Ramon Hall, Director, Uranium Recovery Field Office, NRC, to Jack Ferguson, President, American Nuclear Corporation app. at 3 (Sept. 28, 1990) (on file with NRC/PDR, ACN. 9010100090).

³⁴¹ Letter from Dennis Hemmer, Director, Wyo. DEQ, to Ramon Hall, Director, NRC, Uranium Recovery Field Office, Denver, Colo. 1 (June 18, 1990) (on file with NRC/PDR, ACN. 9007180196). See also *Firm Eyes Gas Hills for Hazardous Waste*, CASPER STAR-TRIBUNE, Sept. 22, 1989, at A3.

³⁴² See Letter from Dennis Hemmer to Ramon Hall, *supra* note 341, at 1, 2; Letter from Dennis Hemmer, Director, Wyo. DEQ, to Ramon Hall, Director, NRC, Uranium Recovery Field Office, Denver, Colo. 1 (July 26, 1990) (on file with NRC/PDR, ACN. 9009040172); Mark Moxley, Wyo. Dept. of Env'tl. Quality, Annual Inspection Report, American Nuclear 2 (June 22, 1989) (on file with archives, Wyo. DEQ).

³⁴³ See Moxley, *supra* note 342, at 2, 3; Memorandum from Paul Michaud, Project Manager, NRC Region IV, to Docket File No. 40-4492, at 1, 2 (Feb. 6, 1990) (on file with NRC/PDR, ACN. 9003010496).

³⁴⁴ WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY, NOTICE OF VIOLATION, Docket File No. 2557-94 (1994) (on file with archives, Wyo. DEQ).

³⁴⁵ Tollefson, *supra* note 320. The sufficiency of American Nuclear's bond in part depends upon whether or not they will have to conform to erosion protection guidelines issued by NRC in 1990. Memorandum from Mark Moxley to Dennis Hemmer, *supra* note 324, at 2. In 1991 American Nuclear claimed that reclamation costs would be raised by several million dollars if they were forced to place additional amounts of

calculations used to determine American Nuclear's bond included the costs of restoring groundwater.³⁴⁶ This omission likely is due to the inexpensive pump system in use. Because of low recharge of water to the aquifer American Nuclear was using only a one-third horsepower pump to pump the aquifer.³⁴⁷ The cost was probably considered insignificant when figuring the bond. Cost may have been minimal, but so too was progress. More than ten years of pumping had lowered the groundwater table and isolated the tailings in an unsaturated zone,³⁴⁸ but water quality had not improved. In 1991 the NRC reported that a comparison of water quality for 1989 and 1991 showed "an increase in all monitored hazardous constituents with the exception of uranium."³⁴⁹ In mid-1993 NRC noted that all groundwater standards except cyanide were exceeded at the monitor well down-gradient of the facility.³⁵⁰ The State of Wyoming is now reclaiming the tailings at American Nuclear. Faced with a difficult long-term groundwater restoration effort, they have chosen a familiar remedy. The state has asked NRC to approve an earlier request by American Nuclear for Alternate Concentration Limits.³⁵¹

protective rock (riprap) over the reclaimed tailings. This rock was not available locally and would be expensive to truck in. James L. Grant and Associates, Erosion Stability Evaluation, American Nuclear Corporation 2 (1991) (on file with NRC/PDR, ACN. 9111190454).

³⁴⁶ See, e.g., Memorandum from Mark Moxley, Dist. II Supervisor, Wyo. DEQ, to File, Permit No. 352, American Nuclear, Inc. 1 (Nov. 8, 1988) (on file with archives, Wyo. DEQ); Memorandum from Paul Michaud to Docket File No. 40-4492, *supra* note 343 at 2; Letter from William Salisbury, American Nuclear Corporation, to Ramon Hall, NRC, Region IV at 1, attach. at 20-22 (Apr. 16, 1992) (on file with NRC/PDR, ACN. 9205050307).

³⁴⁷ AMERICAN NUCLEAR CORPORATION, CORRECTIVE ACTION PROGRAM, 1991 ANNUAL REPORT 2 (Jan. 28, 1992) (on file with NRC/PDR, ACN. 9204140254). American Nuclear feared that they were going to be required to drill new wells in order to find fresh water with which to flush the aquifer. Instead, NRC agreed to the low volume pumping system. See *id.*; AMERICAN NUCLEAR CORPORATION, *supra* note 338, at 8.

³⁴⁸ AMERICAN NUCLEAR CORPORATION, *supra* note 347, at 2.

³⁴⁹ Memorandum from Gary Konwinski to Docket No. 40-4492, Review of the Alternate Concentration Limit Proposal 6 (Aug. 28, 1991) (on file with NRC/PDR, DKT. 40-4492). According to American Nuclear, comparisons with earlier periods were difficult because many of the files had been lost or destroyed, first, when the office was moved from the Gas Hills to Riverton, Wyo., and then during the decommissioning of the mill in the Gas Hills. AMERICAN NUCLEAR CORPORATION, *supra* note 347, at 2.

³⁵⁰ Memorandum from Cynthia Miller-Corbett, Project Manager, Region IV, NRC, to Docket File No. 40-4492, at 2 (Dec. 21, 1993) (on file with NRC/PDR, ACN. 9402240136). Inexplicably, in 1992, NRC accepted, and published in the Federal Register, a projected date of December, 1994, for completion of groundwater corrective actions at American Nuclear. See American Nuclear Corp., Reclamation Schedules, 57 Fed. Reg. 23,436, (1992).

³⁵¹ Telephone Interview, *supra* note 218. See also Letter from Joseph Holonich,

C. Private Waste Dumps: Hopes for New Profits

Another reason little reclamation took place at American Nuclear after 1990 was that the company's attention was focused on a new venture. American Nuclear hoped to make Gas Hills a private waste depository.³⁵² NUKEM, who had purchased 30% of American Nuclear's stock, installed a new president for this purpose. He shifted most of American Nuclear's effort to developing a waste disposal business.³⁵³

In 1992, Wyoming granted American Nuclear a "de minimis" exemption to the state's solid waste regulations.³⁵⁴ American Nuclear was given the right to import and commercially dispose of 10,000 cubic yards (about 21,900 short tons) of uranium mining wastes to be placed in existing tailings impoundments.³⁵⁵ This waste was generated at *in situ* mines that leach uranium, and was similar to the wastes produced at American Nuclear.³⁵⁶ NRC wanted to avoid the proliferation of waste sites³⁵⁷ and had given early approval to American Nuclear's new business venture.³⁵⁸

American Nuclear's plans to expand this disposal operation were dashed when the state turned down a request for a "de minimis" exemption from Pathfinder Mines to import 800,000 tons of uranium mining waste.³⁵⁹ In announcing the rejection of the Path-

Chief, High-Level Waste and Uranium Recovery Projects Branch, NRC, to Richard Chancellor, Wyo. DEQ 1 (Sept. 27, 1994) (on file with NRC/PDR, ACN. 9410040206).

³⁵² See *Firm Eyes Gas Hills for Hazardous Waste*, *supra* note 341, at A3; Letter from John Ferguson, President, American Nuclear Corporation, to Ramon Hall, Director, Uranium Recovery Field Office, NRC Region IV at 1 (Mar. 21, 1991) (on file with NRC/PDR, ACN. 9104240075).

³⁵³ Memorandum from Rick Nevin to Ken Hooks, *supra* note 327, at 2-3.

³⁵⁴ Hugh Jackson, *American Nuclear Hopes to Import Waste to Pay Debt*, CASPER STAR-TRIBUNE, Nov. 18, 1993, at C1.

³⁵⁵ *Id.*; Ray E. Harris, *Industrial Minerals and Uranium Update*, WYO. GEO-NOTES, Feb. 1994, at 38.

³⁵⁶ Jackson, *supra* note 354, at C1. See also Letter from John Ferguson to Ramon Hall, *supra* note 352, at 1-2; 1 DRAFT GENERIC E.I.S., *supra* note 52 (on in-situ mining).

³⁵⁷ Dan Whipple, *Gas Hills Uranium Mill Site to Receive Radioactive Waste*, CASPER STAR-TRIBUNE, Oct. 6, 1990, at A3 (comments by Ed Hawkins, NRC Region IV); 10 C.F.R. §40, app. A, at criterion 2 (1995). For NRC's position on what wastes may and may not be put into a uranium mill tailings impoundment, see Uranium Mill Facilities, Request for Public Comments on Section 11e(2) Byproduct Material in Tailings Impoundments, 57 Fed. Reg. 20,525 (1992).

³⁵⁸ Memorandum from Rick Nevin to Ken Hooks, *supra* note 327, at 3; Whipple, *supra* note 357, at A3.

³⁵⁹ Hugh Jackson, *DEQ Rejects Big Pathfinder Waste Request*, CASPER STAR-TRIBUNE, Mar. 23, 1993, at A1, A8. See generally Betty Stroock, 'De minimis' Radioactive

finder request, a top state official said that Wyoming had probably made a mistake when it approved the first exemption for American Nuclear.³⁶⁰

D. A Federal Bailout for the Uranium Milling Industry

After years of debate, in 1992 Congress finally passed legislation to help the uranium milling industry.³⁶¹ Companies that milled uranium under government contract were made eligible for federal reimbursement for the costs of reclaiming tailings produced under government contract.³⁶² The ostensible reason for the financial rebate is that government contracts did not require reclamation and did not include specific reimbursement for reclamation costs.³⁶³ These same arguments for government help had been made and rejected in the late 1970s when UMTRCA was being debated.³⁶⁴ At the time, however, uranium prices were at an all time high and reclamation costs were not seen as a major problem for the industry.³⁶⁵ After the severe economic reverses of the early 1980s legislation was introduced almost every year to aid the beleaguered uranium industry.³⁶⁶ Title X of the Energy Policy Act of 1992 was the first tangible result of these efforts.³⁶⁷

Tonnage—de What?, CASPER STAR-TRIBUNE, Mar. 15, 1993, at A9.

³⁶⁰ Jackson, *supra* note 354, at C1. Pathfinder had already received authorization from the NRC to greatly expand the type and amount of waste it could accept at its Shirley Basin mill tailings impoundment. Hugh Jackson, *Competitor Jealous of Pathfinder*, CASPER STAR-TRIBUNE, Mar. 12, 1993, at A1, A10. In 1994, Wyoming announced that, to avoid an expensive legal battle with Pathfinder, the State would agree to a de minimis exemption for 78,000 tons of uranium mining wastes. Hugh Jackson, *DEQ Seeks to Expand Pathfinder Waste Dump*, CASPER STAR-TRIBUNE, Mar. 2, 1994, at A1, A10.

³⁶¹ Energy Policy Act of 1992, Pub. L. No. 102-486, §§ 1001-1004, 106 Stat. 2776, 2946-48 (1992) (codified at 42 U.S.C. § 2296(a) (Supp. V 1993)).

³⁶² *See id.* *See also* H.R. REP. NO. 474, 102d Cong., 2d Sess. pt. 1 at 145, 205 (1992), *reprinted in* 1992 U.S.C.C.A.N. 1968, 2028.

³⁶³ H.R. REP. NO. 474, 102d Cong., 2d Sess. pt. 1, at 205 (1992), *reprinted in* 1992 U.S.C.C.A.N. 2028. *See also* David Hackett, *Lobbyists Say Wallop Tried to Shift Nuke Costs to Public*, CASPER STAR-TRIBUNE, Oct. 19, 1992, at A1, A10 (comments by John Atkins, Cogema, Inc.).

³⁶⁴ *See* H.R. REP. NO. 1480, 95th Cong., 2d Sess. pt. 2, at 29, 30 (1978), *reprinted in* 1978 U.S.C.C.A.N. 7456, 7457. *See also supra* notes 68-72 and accompanying text. UMTRCA specifically prohibited the spending of federal funds designated to clean up abandoned mill sites at mill sites that were still licensed. 42 U.S.C. § 7925(a) (1988); Grammer, *supra* note 13, at 487-88.

³⁶⁵ *See, e.g.*, 1 DRAFT GENERIC E.I.S., *supra* note 36, at 17 (where the NRC estimates that the costs of covering tailings to achieve a 2 pCi/m³ radon emission level would be from .5 percent to 1 percent of the value of the yellowcake obtained).

³⁶⁶ *See supra* note 120.

³⁶⁷ Title X of the Energy Policy Act of 1992, 106 Stat. 2776 (1992) contains §§

There are thirteen mills where tailings created under government contracts prior to 1970 are commingled with tailings generated under later private contracts. The tailings produced under government contracts at these mills make up from 12% to 63% of the total tailings to be reclaimed.³⁶⁸ Companies will be eligible for a reimbursement for documented costs of the portion of the tailings produced for the government up to \$5.50 per dry short ton of tailings reclaimed.³⁶⁹ One of the last acts of the management at American Nuclear before closing the company was to file for a federal Title X reimbursement of \$900,000.³⁷⁰ American Nuclear was one of only a few companies that needed financial help to complete reclamation. Yet, even with the enactment of this federal assistance, the company still went out of business. Most of the other uranium mills are subsidiaries of healthy, diversified companies which are quite capable of financing reclamation.³⁷¹ These companies will now be eligible for a welcome, but unneeded, federal reimbursement. The reimbursement is even retroactive. Companies that had completed most of their reclamation before passage of the law are also eligible for the reimbursement.³⁷²

1001-1004 (codified at 42 U.S.C. § 13201 (Supp. V 1993)) and has become the common appellation for this federal rebate to private uranium companies.

³⁶⁸ The metric tonnage milled under government contract and the percentage of the total tailings to be reclaimed that these government milled tailings represent are as follows: TVA-Edgemont (S.D.) 1.6 million metric tons, 50% of total tonnage; Atlas Corp. (Ut.) 6 mil. m. tons, 63%; Amer. Nuc. Corp. (Wy.) 2.1 mil. m. tons, 39%; Petrotomics (Wy.) 0.7 mil. m. tons, 12%; Umetco (Wy.) 2.1 mil. m. tons, 24%; West. Nuc. Inc. (Wy.) 3.4 mil. m. tons, 49%; Pathfinder (Lucky Mc mill) 2.7 mil. m. tons, 25%; Anaconda-Bluewater (N.M.) 8.8 mil. m. tons, 37%; Homestake (N.M.) 11.4 mil. m. tons, 52%; Quivira (N.M.) 10 mil. m. tons, 30%; Dawn Mining (Wa.) 1.1 mil. m. tons, 38%; Cotter Corp. (Co.) 0.3 mil. m. tons, 12%; Umetco (Co.) 5.7 mil. m. tons, 54%. See *Joint Hearing*, *supra* note 47, at 197.

³⁶⁹ 42 U.S.C. § 2296(a) (Supp. V 1993). The total payments to these thirteen uranium licensees cannot exceed \$270 million, adjusted for inflation. *Id.* This money must be appropriated by Congress. It is not an entitlement. In late 1993 the President signed the Energy and Water Appropriations Bill, which appropriated \$41.7 million for tailings cleanup by uranium licensees. Energy and Water Development Appropriations Act, Pub. L. No. 103-316, 108 Stat. 1715 (1994) (codified at 42 U.S.C. § 2061 (Supp. V 1993)).

³⁷⁰ Letter from William Salisbury to Director, *supra* note 316, at 5.

³⁷¹ This point has been made by several commentators. See Hackney, *supra* note 114, at 196 n.194; *Domestic Uranium Industry and Enrichment Program: Hearings on H.R. 4934 and H.R. 5181 Before the Subcomm. on Energy and Power of the House Comm. on Energy and Commerce*, 100th Cong., 2d Sess., 209 (1988) (comments by Representative Mike Synar).

³⁷² 42 U.S.C. § 2296(a)-3(3) (Supp. V 1993).

IX. CASE 6: PATHFINDER MINES CORPORATION'S LUCKY MC URANIUM MILL, WYOMING

A. Introduction

Pathfinder Mines' Lucky Mc mill is located adjacent to American Nuclear's mill in the Gas Hills uranium producing area of Wyoming. These two mills have faced similar problems in groundwater restoration. Similarities end there, however. Pathfinder Mines is a part of COGEMA, a French energy conglomerate.³⁷³ This corporate connection gives Pathfinder Mines access to finances and expertise that were not available to financially strapped American Nuclear. Groundwater clean-up at Pathfinder Mines also has benefited from an unusual resolve to overcome problems other mills saw as too difficult.

B. Groundwater Contamination

Lucky Mc mill stored tailings in a series of six ponds created by building clay core earthen dams down a ravine.³⁷⁴ The first three ponds nearest the mill held saturated coarse grained tailings and the last three only liquids.³⁷⁵ In 1963 a flood caused tailings to go over one of the dams, spilling 23 million gallons.³⁷⁶ Afterwards, a new dam enlarged the capacity of the ponds.³⁷⁷ The main seepage problem at the Lucky Mc mill came from the two tailings ponds (1 and 2) nearest the mill. In 1984, Wyoming's Chief Hydrologist explained:

It appears that the major problem remaining at this site is the

³⁷³ See Ray E. Harris, *Uranium Update*, WYO. GEO-NOTES, May 1994, at 35, 36 (information on COGEMA's corporate structure).

³⁷⁴ See Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 1-3 (June 11, 1984) (on file with archives, Wyo. DEQ).

³⁷⁵ PATHFINDER MINES CORP., LUCKY MCMINE, SUPPLEMENT TO APPLICANT'S ENVIRONMENTAL REPORT, at 1-1, 1-2 (1992) (on file with NRC/PDR, ACN. 9211300237).

³⁷⁶ 3 FINAL GENERIC E.I.S., *supra* note 73, at T-10.

³⁷⁷ See *id.*; Memorandum from Gary Konwinski to Docket File No. 40-2259, *supra* note 374, at 3. In the late 1980's, the Lucky McMill had over 12 million tons of tailings which covered more than 200 acres. See PATHFINDER, SOURCE MATERIAL LICENSE RENEWAL APPLICATION AND ENVIRONMENTAL REPORT, LUCKY MC URANIUM MILL 23 (Nov. 1989) (on file with NRC/PDR, DKT. 40-2259); Statement of Bob Poyser, testifying before the Envtl. Protection Agency, Pathfinder Mines, Regarding Proposed Rulemaking for 40 C.F.R. § 192(D) (1995), at 2 (Jan. 21, 1992) (on file with EPA Air Docket, Docket No. A-91-67).

unreclaimed status of Tailings Ponds No. 1 and No. 2. Although these ponds are no longer used, they continue to impound surface water runoff which continues to recharge the ground-water mound beneath the ponds. Additionally, a ditch which apparently carries laboratory wastes, etc. still transgresses Tailings Pond No. 1 thereby providing additional water and contaminants for recharge.³⁷⁸

At a 1984 meeting, the state and NRC "agreed that we must get Pathfinder moving on closing up tailings cells 1 and 2."³⁷⁹ However, Pathfinder's on and off plans to resume operations and reuse these ponds made it difficult to get reclamation underway.³⁸⁰ It was not until 1989 that both ponds received interim covers.³⁸¹ When finally in place, these covers prevented melting snow from leaching tailings into the aquifer below.

In 1980 Pathfinder installed collection wells to intercept seepage from the ponds and limit its migration through the underlying alluvium.³⁸² Water and seepage collected by these wells was not pumped back to the leaking ponds, as was done at other mills. Rather, it was pumped to the pond furthest downgrade for evaporation.³⁸³ This last tailings pond was constructed with a fine-grained shale to prevent leakage.³⁸⁴

Pumping of the aquifer had more effect on the quantity than quality of water. This was the same problem found at American Nuclear. By 1989 yields from pumping at Lucky Mc mill had decreased from an initial 21 gpm to only 10 gpm of seepage.³⁸⁵ By

³⁷⁸ Memorandum from Bill Kearney, Chief Hydrologist, Wyo. DEQ, to File, Pathfinder Mines Corp., Lucky Mc Mine 1 (Mar. 7, 1984) (on file with NRC/PDR, ACN. 8404100116).

³⁷⁹ Letter from Rick Engelmann, Dist. II, Engineer, Wyo. DEQ, to Dr. Harry Pettengill, NRC, Uranium Recovery Field Office, Denver, Colo. 1 (Apr. 2, 1984) (on file with NRC/PDR, ACN. 8405140224).

³⁸⁰ See PATHFINDER, *supra* note 377, at 23. See Letter from T.W. Hardgrove, Environmental Coordinator, Lucky Mc Mine, to Edward Hawkins, NRC, Uranium Recovery Field Office, Denver, Colo. 1, attach. at 1 (May 3, 1989) (on file with NRC/PDR, ACN. 8906090095).

³⁸¹ See Letter from T.W. Hardgrove to Edward Hawkins, *supra* note 380, attach. at 2-4; Statement of Bob Poyser, *supra* note 377, at 2.

³⁸² See PATHFINDER, *supra* note 377, at 8.

³⁸³ See Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 1 (Dec. 16, 1988) (on file with NRC/PDR, ACN. 8901300212).

³⁸⁴ *Id.*

³⁸⁵ See Letter from T.W. Hardgrove, Environmental Coordinator, Lucky Mc Mine, to Edward Hawkins, NRC Uranium Recovery Field Office, Denver 1 (Mar. 1, 1989) (on file with NRC/PDR, ACN. 8903210412); Memorandum for Docket File No. 40-2259, from Candice Jierree, Project Manager, NRC Region IV at 2 (Mar. 27, 1987) (on file

Pathfinder's own admission, "unfortunately, pumping has not resulted in any real improvement in water quality in the aquifer east of the two ponds. . . . Pumping has, at best, only held the line on water quality for the past 8 years. In some instances, there has been even further degradation in water quality."³⁸⁶ NRC analysis in 1988 concluded that groundwater protection standards were exceeded for arsenic, beryllium, cadmium, chromium, nickel, combined radium-226 and 228, thorium-230, selenium, and uranium.³⁸⁷ This is essentially the situation which exists today at American Nuclear. At the Pathfinder mill, however, the company set about to resolve the contamination problem.

C. Successes in Cleaning-up Groundwater

Pumping of groundwater at several mills has been hampered by low recharge rates and diminishing amounts of water. However, hazardous constituents remain to contaminate the water during aquifer recharge.³⁸⁸ When confronted with this situation, companies typically argue that further restoration efforts are useless and standards should be eased.³⁸⁹ Pathfinder took a different approach. In the late 1980s it announced "we have elected not to pursue the option of alternate concentration limits (ACLs) at this time. We feel that the pursuit of aquifer remediation should take precedent at this site at this time."³⁹⁰ Consultants hired by Pathfinder confirmed that the problem was a lack of water to flush contaminants.

The constituents that have already migrated east of the ponds will continue to be present in elevated concentrations for the duration of any practical time frame one wants to consider as long as the required medium for their removal is in short supply. That medium is water, and at this site it is obvious that any source of natural recharge is very limited.³⁹¹

Drying and covering the tailings would stop new contaminants from entering the aquifer but would not clean up contamination already present. Pathfinder therefore developed a new groundwater

with NRC/PDR, ACN. 8704070060).

³⁸⁶ Letter from T.W. Hardgrove to Edward Hawkins, *supra* note 385, at 1, 2.

³⁸⁷ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 1 (Aug. 18, 1988) (on file with archives, Wyo. DEQ).

³⁸⁸ See *supra* note 210 and accompanying text.

³⁸⁹ See, e.g., *supra* the cases of UNC and American Nuclear Corp.

³⁹⁰ Letter from T.W. Hardgrove to Edward Hawkins, *supra* note 385, at 2.

³⁹¹ *Id.*

plan to attack past contamination. In May 1989 a fresh water injection system was added.³⁹² Fresh water from a well was piped to two injection wells and then pumped into the aquifer at roughly 26 gpm.³⁹³ The plan was that this fresh water would flush out contaminants.³⁹⁴ With fresh water injection the collection wells could again remove water and hazardous constituents from the aquifer.³⁹⁵

Results from this fresh water injection are promising. In 1991 NRC noted that "[s]elenium, radium-226 and 228, thorium-230, cadmium, and chromium have shown some decreases in concentrations."³⁹⁶ By 1993 NRC could state that "[t]he combination of fresh water injection and ground-water recovery have had a favorable effect on groundwater quality."³⁹⁷ Pathfinder reported continued progress in December 1994 and indicated that groundwater standards would probably be reached, with possible exceptions for nickel and uranium.³⁹⁸

Pathfinder's efforts provide one of the few success stories in groundwater clean-up under UMTRCA Title II. Even with initial success, Pathfinder's projected date for completion of its groundwater clean-up is September 2004.³⁹⁹ In addition to finances, a successful remediation effort also requires perseverance. Pathfinder brought both to its task. In American Nuclear's case, money was a missing factor. Other companies with adequate funds have been unwilling to see groundwater remediation as a long-term endeavor. NRC has encouraged this lack of commitment to effective clean-up by allowing companies to publish unrealistic clean-up dates in the Federal Register which obviously cannot be met without easing standards.

³⁹² PATHFINDER, *supra* note 377, at 8.

³⁹³ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 1 (Mar. 16, 1990) (on file with NRC/PDR, ACN. 9004040155).

³⁹⁴ *See id.* at 1-3.

³⁹⁵ *See id.* In 1989, Pathfinder also drilled new collection wells in tailings pond 1 to pump seepage from directly underneath the tailings pond. *See* PATHFINDER, *supra* note 377, at 8.

³⁹⁶ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 2 (Mar. 11, 1991) (on file with NRC/PDR, ACN. 9103190316).

³⁹⁷ Memorandum from Gary Konwinski, Project Manager, NRC Region IV, to Docket File No. 40-2259, at 3 (Mar. 30, 1993) (on file with NRC/PDR, ACN. 9304090298).

³⁹⁸ Letter from T.W. Hardgrove, Environmental Coordinator, Lucky Mc Mine, to Joseph Holonich, Chief, NRC, High-Level Waste and Uranium Recovery Projects Branch, Rockville, MD 1 (Dec. 22, 1994) (on file with NRC/PDR, ACN. 9501030093).

³⁹⁹ Pathfinder Mines Corp., 57 Fed. Reg. 43,265 (1992).

X. CASE 7: KENNECOTT URANIUM COMPANY'S SWEETWATER URANIUM MILL, WYOMING

A. Introduction

The Sweetwater uranium mill was built as a state of the art uranium operation in the late 1970s by Minerals Explorations Company, a subsidiary of Union Oil Company of California.⁴⁰⁰ Extra precautions were taken to minimize environmental impacts because the mill was to be built near an important source of surface water for desert wildlife and over a major aquifer.⁴⁰¹ This concern for the environment, however, evaporated with the end of the uranium boom. In the final analysis, there has been significant environmental degradation at the site.⁴⁰²

The Sweetwater mill began operations in 1980 and ceased operations when it was placed on standby in May 1983.⁴⁰³ During this period, milling produced 2.2 million cubic yards of tailings.⁴⁰⁴ In 1991 a joint venture which included the Kennecott Uranium Company, a subsidiary of Kennecott Corporation, purchased the facility.⁴⁰⁵ Kennecott plans to use the Sweetwater mill to process ore from an underground uranium mine being developed some 25 miles to the north. Kennecott decided that it would be easier to reactivate Sweetwater's existing milling permit than to construct and permit a new mill.⁴⁰⁶

The Sweetwater mill is located in the Red Desert in an isolated part of Sweetwater County in southwestern Wyoming. The area in which the mine and mill complex were built includes critical win-

⁴⁰⁰ URANIUM RECOVERY FIELD OFFICE, NRC, ENVIRONMENTAL ASSESSMENT IN CONSIDERATION OF THE RENEWAL OF SOURCE MATERIAL LICENSE SUA-1350 FOR SWEETWATER URANIUM PROJECT 1 (Mar. 24, 1992) (on file with NRC/PDR, ACN. 9204130224). See also *infra* notes 413-417 and accompanying text.

⁴⁰¹ See *infra* notes 407-411 and accompanying text.

⁴⁰² See *infra* notes 436-444 and accompanying text.

⁴⁰³ See, e.g., Letter from Rick Engelmann, District Engineer, Wyo. DEQ, to Houston Snyder, Minerals Exploration Co. at 1 (Apr. 7, 1981) (on file with archives, Wyo. DEQ) (confirming that the mill was operating in 1980); URANIUM RECOVERY FIELD OFFICE, *supra* note 400, at 1.

⁴⁰⁴ Sweetwater Uranium Mine, Minerals Exploration Co., Annual Mining and Reclamation Report at F-1 (Nov. 1, 1978) (on file with archives, Wyo. DEQ). In 1985 the GAO reported that the Minerals Exploration mill site contained 3.5 million metric tons of tailings. *Joint Hearing*, *supra* note 47, at 197.

⁴⁰⁵ URANIUM RECOVERY FIELD OFFICE, *supra* note 400, at 1.

⁴⁰⁶ Hugh Jackson, *Joint Venture Proposes Green Mountain Underground U-Mine*, CASPER STAR-TRIBUNE, Aug. 25, 1992, at A1, A10.

tering grounds for one of Wyoming's largest antelope herds.⁴⁰⁷ It is also an important source of water and habitat for birds and other desert wildlife.⁴⁰⁸ The Chain Lakes are located nearby and a Class I aquifer underlies the mining complex.⁴⁰⁹ One high ranking state environmental official said that the water in the basin "was some of the best in the state of Wyoming."⁴¹⁰ In discussing the importance and fragility of this water resource, a state hydrologist explained in the early 1980s that

its Class I status reflects its potential use in a water poor region. It is that potential use that the operator must protect. . . . There are no hard numbers of the cost of restoring the aquifer, once contamination has occurred. Furthermore, there is no guarantee that such restoration can be achieved.⁴¹¹

The decision in the late 1970s to open a uranium mine and mill in this area of important wildlife habitat was opposed by numerous environmental groups. These groups threatened legal action and the Union Oil Company received considerable negative publicity over the issue.⁴¹² The legal challenge was withdrawn only after the NRC required that mill tailings be stored partially below ground and after the company agreed to negotiate with the protesting environmental groups.⁴¹³ The end result was a mine and mill complex

⁴⁰⁷ See Letter from Dale Strickland, Supervisor of Biological Services, Wyo. Game and Fish Dept., to Gary Beach, Wyo. DEQ (Oct. 16, 1978) (on file with archives, Wyo. DEQ); *Way Clearing for Red Desert Uranium Mine*, ROCK SPRINGS DAILY ROCKET-MINER, Oct. 26, 1978.

⁴⁰⁸ See Robert Waggener, *Touring the Red Desert*, GREEN RIVER STAR, June 25, 1980, at B3.

⁴⁰⁹ Memorandum from Chris Lidstone, Hydrologist, Wyo. DEQ, to Gary Beach, Wyo. AML Supervisor 4 (Sept. 23, 1983) (on file with NRC/PDR, ACN. 8310240045); Memorandum from Dennis Fransway et al., Principal Environmental Analyst, Wyo. DEQ, to Mark Moxley, Acting Supervisor, Wyo. DEQ, Dist. II at 7 (May 25, 1982) (on file with archives, Wyo. DEQ).

⁴¹⁰ *State Reconsiders Request for Mine in Red Desert*, ROCK SPRINGS DAILY ROCKET-MINER, June 10, 1978 (quoting Walter C. Ackerman, Director, Land Quality Division, Wyo. DEQ).

⁴¹¹ Memorandum from Chris Lidstone, *supra* note 409, at 4.

⁴¹² See Paul Krza, *Mine May Decide Desert's Future*, CASPER STAR-TRIBUNE, Sept. 21, 1978, at 17; Petition Objecting to Issuance of Mining Permit at 2, In re Mining Permit Application, Temporary Filing Number 1 1/111, Mineral Exploration Co. v. Wyo. Outdoor Council et al., Before the Wyo. Environmental Quality Council (Oct. 10, 1978) (on file with archives, Wyo. DEQ).

⁴¹³ Motion to Withdraw Petition Objecting to Issuance of Mining Permit (with Stipulation of Dismissal), submitted by Josephine Porter, Attorney for Petitioners, Before the Wyo. Environmental Quality Council (Oct. 26, 1978) (on file with archives, Wyo. DEQ). See also Krza, *supra* note 412, at 17.

designed to avoid many of the environmental problems associated with other uranium operations.

Mill tailings would be deposited in a synthetically lined, partially below ground pit instead of the typical above ground, unlined pile or pond within a diked area.⁴¹⁴ Water pumped from the open pit mine would be treated before it was discharged into the desert.⁴¹⁵ The company would finance studies of how this discharged mine water affected both desert flora and fauna.⁴¹⁶ The impact of pumping the mine pit on water levels in the nearby Chain Lakes would also be carefully monitored.⁴¹⁷

This was the plan. The reality was quite different, at least as concerns protection of groundwater. The environmental vigilance demonstrated when the mill was being built in the late 1970s quickly dissipated in the early 1980s when the health of the industry became a new major priority at both state and federal levels.⁴¹⁸

B. The Tailings Pond Liner Fails

In December 1980, after only months of operation, a 130-foot seam separation was found in the synthetic tailings pond liner.⁴¹⁹ The state immediately inspected the pond and asked that the area around the rip be diked off and pumped out.⁴²⁰ The company was warned that this "could prevent a lot of possible problems which could result if radioactive water got into the groundwater."⁴²¹ Minerals Exploration believed that the liner would be further damaged in the process of constructing the dike and quickly made temporary repairs.⁴²² In their view, the state had over reacted to a minor inci-

⁴¹⁴ S. MIKOL, WYO. GAME AND FISH REPORT - UNION MINERALS EXPLORATION COMPANY (May 1, 1980) (on file with archives, Wyo. DEQ); OFFICE OF RADIATION PROGRAMS, *supra* note 22, at 4-35.

⁴¹⁵ Memorandum from Dennis Fransway et al., *supra* note 409, at 7-8.

⁴¹⁶ Motion to Withdraw Petition, *supra* note 413, at 5-6; *Update: Minerals Exploration*, THE CROSSROADS MONITOR (Wyo. Outdoor Council), June-July, 1979, at 8-9.

⁴¹⁷ Motion to Withdraw Petition, *supra* note 413, at 1-5.

⁴¹⁸ See generally *supra* notes 113-120 and accompanying text; Collins, *supra* note 16, at 495-99, 529-30 (on accomodation to the uranium industry in applying Wyoming's mine reclamation rules).

⁴¹⁹ Letter from Houston Snyder, Minerals Exploration Co., to Francis LaBarge, Water Quality Engineer, Wyo. DEQ at 1 (Jan. 13, 1981) (on file with archives, Wyo. DEQ).

⁴²⁰ Memorandum to File, Liner Break in Tailings Pond at Minerals Exploration Co., from Frank LaBarge, Wyo. DEQ at 2 (Jan. 2, 1981) (on file with archives, Wyo. DEQ).

⁴²¹ *Id.* at 3.

⁴²² Letter from Houston Snyder, *supra* note 419, at 1.

dent. "Small leaks from this system would/will have an infinitesimal effect on the environment as compared to other existing uranium tailings disposal systems now in use in Wyoming."⁴²³

By 1983 there were three more incidents where holes or tears were found in the liner.⁴²⁴ Floating debris and waves were causing punctures and tears.⁴²⁵ According to NRC, the long-term solution was a non-erosive shoreline.⁴²⁶ However, as the mill was closing because of low uranium prices, NRC accepted temporary repairs and planned to re-examine the issue of the liner when the mill reopened.⁴²⁷

Temporary repairs were not very effective. In 1985 a state inspection reported that "continued wind and water erosion of the cell bank has caused these holes to grow."⁴²⁸ The state's earlier anxiety about groundwater contamination seemed to have disappeared. A state inspector noted that Minerals Exploration Company "is now utilizing a misting system to enhance evaporation of the tailings liquid. When the liquid level drops below the holes, repairs will be made to the liner."⁴²⁹

This same nonchalant attitude was apparent in 1986, even though by then, leakage from past tears had produced a plume of contaminants underneath the tailings pond.⁴³⁰ In June 1986 the state reported that "the lower liner is patched as necessary as the water level decreases. If and when mining operations are resumed and this cell is used, the liner will need to undergo complete repair. The plume from the tailings cell is continuing to be monitored."⁴³¹

By late fall of 1986 Minerals Exploration had installed wells to catch the seepage from the pond and pump it back into the tailings impoundment.⁴³² The company appeared to be as unconcerned about the contaminated aquifer as were state regulators. Indeed,

⁴²³ *Id.* at 3.

⁴²⁴ Memorandum to Docket File No. 40-8584, from Gary Konwinski, Project Manager, Uranium Recovery Field Office, NRC Region IV at 2 (Nov. 3, 1983) (on file with NRC/PRD, ACN. 8312020103).

⁴²⁵ *Id.*

⁴²⁶ *Id.* at 3.

⁴²⁷ *Id.*

⁴²⁸ STEVE GARLAND, WYO. DEQ, ANNUAL INSPECTION REPORT, MINERALS EXPLORATION CO. at 3 (Apr. 15, 1985) (on file with archives, Wyo. DEQ).

⁴²⁹ *Id.*

⁴³⁰ JANE VALERIUS, WYO. DEQ, ANNUAL INSPECTION REPORT at 2 (June 19, 1986) (on file with archives, Wyo. DEQ).

⁴³¹ *Id.*

⁴³² MINERALS EXPLORATION CO., ANNUAL MINING AND RECLAMATION REPORT, SWEETWATER URANIUM MINE A-2 (Oct. 31, 1986) (on file with archives, Wyo. DEQ).

Minerals Exploration felt that restoring the aquifer would be relatively easy. "If required, groundwater restoration would consist of pumping 75 to 400 gallons per minute for three or four years."⁴³³ Total costs for groundwater restoration, based on 42 months of pumping, were estimated by Minerals Exploration to be \$61,600.⁴³⁴ Neither the state nor NRC questioned these estimates which were used to set the company's bond.⁴³⁵

In 1987 groundwater contamination worsened.⁴³⁶ Yet as late as 1990 the state was unsure if the cause was still a leaking liner.

According to our files, it is assumed that the tailings impoundment liner is intact (i.e., does not leak) below the current water level. However, no documentation of liner integrity could be found. . . . The condition of the liner material above the current water level raises concern over the condition below the water level.⁴³⁷

In 1991 the state estimated that groundwater restoration would require another four years of pumping.⁴³⁸ In 1992, in their third annual groundwater corrective action review, Minerals Exploration Company (MEC) stated that they were "unable at this time to estimate the time required to reach compliance. MEC will continue to pump back and aggressively mitigate the remaining contamination."⁴³⁹

Kennecott, the new owner, must now deal with a major contamination problem. In 1991 over 16 million gallons of water were pumped from the aquifer, thus removing 750,000 pounds of hazardous constituents.⁴⁴⁰ Despite this herculean effort, uranium concen-

⁴³³ *Id.* at F-7.

⁴³⁴ *Id.*

⁴³⁵ See, e.g., JACK SMITH, WYO. DEQ, ANNUAL INSPECTION REPORT, MINERALS EXPLORATION CO. at 1, 2 (May 23, 1988) (on file with archives, Wyo. DEQ). But cf. Letter from Mark Moxley, District II Supervisor, Land Quality Division, Wyo. DEQ to Oscar Paulson, Facility Supervisor, Minerals Exploration Co. attachment at 2 (Feb. 11, 1991) (on file with NRC/PDR, ACN. 9103190036) (where the state questions estimates of reclamation costs and time).

⁴³⁶ Memorandum to File, Minerals Exploration Co., from Steve Ingle, Hydrologist, Wyo. DEQ 3 (Feb. 5, 1988) (on file with archives, Wyo. DEQ).

⁴³⁷ Letter from Doug Gilmer, Environmental Senior Analyst, Wyo. DEQ, to Ramon Hall, Director, NRC Uranium Recovery Field Office, Region IV 2 (Mar. 6, 1990) (on file with NRC/PDR, ACN. 9005100090).

⁴³⁸ Memorandum to File, *supra* note 435, attach. at 2.

⁴³⁹ Letter from George Worman, Radiation Safety Officer, Minerals Exploration Co., to Ramon Hall, Director, NRC, Uranium Recovery Field Office, Region IV attachment 6 (Jan. 24, 1992) (on file with NRC/PDR, DKT. 40-8584).

⁴⁴⁰ Memorandum to Docket File No. 40-8584, from Joel Grimm, Project Manager, NRC Region IV at 1 (Sept. 3, 1992) (on file with NRC/PDR, ACN. 9209180088).

trations remained one to two orders of magnitude above the groundwater protection standard. Total dissolved solids occurred as high as six times the standard. In addition, lead-210 and radium routinely exceeded the groundwater standard.⁴⁴¹ NRC's conclusion was that "no significant change has occurred in the groundwater quality during the period of record."⁴⁴²

In a 1995 review of their groundwater corrective action program Kennecott was optimistic about a new pump that would increase the amount of water removed from the aquifer to 18.5 million gallons per year.⁴⁴³ Again, Kennecott was unable to estimate the time required to reach compliance. The NRC was assured, however, as in the past, that Kennecott would continue to pump back and aggressively mitigate the remaining contamination.⁴⁴⁴

The Sweetwater uranium mill is one of the newest in the United States. It was one of the last mills built before the uranium market crashed. In the late 1970s when the mill was built there was a new emphasis on protecting the environment. Yet, today, the situation at the Sweetwater mill is not much different from that found at older mills: seepage contaminated an important aquifer; regulators allowed this situation to deteriorate in the 1980s; and attempts to restore the aquifer indicate the task will be difficult. However, there is one difference. The new operator, Kennecott Uranium Company, is preparing to re-open the mill as soon as the uranium market improves. In a plan resonant with the promise of the late 1970s, Kennecott is proposing to build a new state of the art tailings impoundment at the site to be used when milling resumes.⁴⁴⁵

XI. CASE 8: THE ATLAS CORPORATION'S MILL, MOAB, UTAH

A. Introduction

The Atlas uranium mill located just outside of Moab, Utah, is a fitting final case study. It allows a review of each of the major problems associated with the implementation of UMTRCA. These

⁴⁴¹ *Id.* at 2.

⁴⁴² *Id.*

⁴⁴³ Kennecott Uranium Co., Sweetwater Facility, Annual Program Review 2 (Jan. 26, 1995) (on file with NRC/PDR, ACN. 9502070219).

⁴⁴⁴ *Id.* at 5.

⁴⁴⁵ See Kennecott Uranium Co., Response to NRC Comments Conceptual Design Tailings Management Study 1 *passim* (Jan. 18, 1995) (on file with NRC/PDR, ACN. 9501310256).

problems include serious groundwater contamination from leaking tailings, exacerbated in the 1980s by regulatory neglect; airborne particulates and excessive radon emissions near a populated area; the threat of future floods endangering the tailings impoundment; a company in financial difficulties facing possible bankruptcy; and inadequate financial guaranties to ensure reclamation.

The Atlas tailings impoundment and mill are located on the north bank of the Colorado River, upstream from the town of Moab. The tailings impoundment, at one point, is as close as 750 feet to the Colorado River.⁴⁴⁶ New businesses serving tourists are rapidly moving north of Moab, along the Colorado River, toward the tailings pile.⁴⁴⁷ The Moab area has become a mecca for mountain bikers, four wheelers, and river rafters. The town is also the major center for motels and restaurants serving visitors to two nearby national parks, Arches and Canyonlands.⁴⁴⁸

The mill has been owned by Atlas since 1962. For many years the company discharged mill wastes into the Colorado River.⁴⁴⁹ Beginning in 1977 tailings were placed in a single impoundment constructed from coarse tailings.⁴⁵⁰ During operations, tailings were discharged from multiple spigots around the perimeter of a starter dam. The coarse sand was deposited around the edges to create the impoundment, with the fine sand and solution being placed toward the center.⁴⁵¹ When operations ceased in 1984 the impoundment contained 9.6 million metric tons of tailings.⁴⁵² Today these tailings, which are located next to the partially dismantled mill, cover 130 acres and stand over 100 feet high a short distance from the Colorado River.⁴⁵³

⁴⁴⁶ OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, U.S. NUC. REG. COMM., DRAFT ENVIRONMENTAL IMPACT STATEMENT RELATED TO RECLAMATION OF THE URANIUM MILL TAILINGS AT ATLAS SITE, MOAB, UTAH 3-19 (Jan. 1996) [hereinafter ATLAS DRAFT E.I.S.].

⁴⁴⁷ Personal observation, March 1994. See also ATLAS DRAFT E.I.S., *supra* note 446, at 3-11, 3-12.

⁴⁴⁸ In 1994 discussions about the Atlas tailings, the State of Utah noted that the population in the vicinity of the tailings rises from 4,000 to around 20,000 people during tourist season. The State also pointed out that there are 1.2 million visitors annually to the nearby national parks. Division of Radiation Control, Utah Dept. of Envtl. Quality, Atlas EIS Public Scoping Written Comments 4 (May 12, 1994) (on file with author).

⁴⁴⁹ FINAL GENERIC E.I.S., *supra* note 73, at T-8; OFFICE OF RADIATION PROGRAMS, *supra* note 22, at 4-24.

⁴⁵⁰ OFFICE OF RADIATION PROGRAMS, *supra* note 22, at 4-24.

⁴⁵¹ *Id.*

⁴⁵² *Joint Hearing*, *supra* note 47, at 197.

⁴⁵³ Reclamation of Atlas Corporation's Uranium Mill Facility at Moab, UT, 59 Fed.

Atlas, a Denver corporation, has in recent years been active in gold mining in Nevada. In early 1993, it suffered major losses due to low gold prices and operational problems.⁴⁵⁴ In the fall of 1993 the company was rescued in an \$8.4 million stock deal by Phoenix Financial Holdings, Inc. of Toronto, Canada.⁴⁵⁵ At this time, Atlas agreed to turn over control of its board to these Canadian investors.⁴⁵⁶

B. Tailings Seeping into the Groundwater and the Colorado River

The Atlas mill stopped operations in March 1984. Atlas' license to process uranium expired soon afterward. The NRC denied an application to renew the operating license because of Atlas' failure to meet bonding requirements.⁴⁵⁷ In July 1987 Atlas was ordered to begin decommissioning the mill and to decontaminate and reclaim the site.⁴⁵⁸

In 1988 the NRC determined that hazardous constituents in the groundwater adjacent to the tailings pile exceeded protection standards for chromium, molybdenum, nickel, radium, selenium, uranium, and vanadium.⁴⁵⁹ Uranium concentrations exceeded the EPA groundwater protection limit by as much as 918 times.⁴⁶⁰ In response to this contamination Atlas produced a groundwater corrective action plan.⁴⁶¹ In this plan the company proposed that natural dissipation be allowed to remove the plume of hazardous constituents which had formed in the groundwater next to the tailings.⁴⁶² Essentially, Atlas proposed that contaminated groundwater dissipate

Reg. 14,912, 14,913 (1994).

⁴⁵⁴ *Atlas Corp. President Resigns Amid Crisis: Stock Plunges \$ 2.25*, WALL ST. J., Feb. 11, 1993, at B10.

⁴⁵⁵ *Atlas Corp. Turns Control of Company over to Canadians*, WALL. ST. J., Sept. 7, 1993, at A5.

⁴⁵⁶ *Id.*

⁴⁵⁷ EPA ASSESSMENT OF URANIUM MILL TAILING PILES at 1 (Oct. 1991) (on file with EPA Air Docket, Docket No. A-91-67).

⁴⁵⁸ *Id.*

⁴⁵⁹ Memorandum for Docket File No. 40-3453, from Gary Konwinski, Program Manager, NRC Region IV 1 (June 22, 1990) (on file with NRC/PDR, ACN. 9007160255).

⁴⁶⁰ Division of Radiation Control, Utah Dept. of Envtl. Quality, Comments Addressing the NRC's Proposal to Amend Source Material License SUA-917, Atlas Corporation Moab Mill at 1 (Aug. 19, 1993) (on file with author).

⁴⁶¹ Memorandum to Docket File No. 40-3453, *supra* note 459, at 1.

⁴⁶² *Id.*; Letter from Edward Hawkins, Branch Chief, Uranium Recovery Field Office, NRC Region IV, to Atlas Minerals Corporation 1 (Apr. 12, 1989) (on file with NRC/PDR, ACN. 8905170015).

by draining into the Colorado River. Atlas' position was that seepage into the river would be diluted by the volume of water in the Colorado River.⁴⁶³ The company emphasized that, because of dilution, seepage from the tailings created no measurable impact on downstream water quality.⁴⁶⁴

The NRC rejected Atlas' proposal for a clean-up by natural dissipation. The NRC estimated that it would take 75 years for the tailings to drain sufficiently to reach nondetectable levels in the groundwater next to the mill.⁴⁶⁵ According to the NRC this was "not a corrective action program, but rather an application for Alternate Concentration Limits."⁴⁶⁶ Atlas was told that "considering natural dilution as a corrective action program is not an option at this site, or any other tailings impoundment."⁴⁶⁷ A corrective action program "must incorporate the concepts of removing or treating hazardous constituents in place."⁴⁶⁸

Despite such resolute words, the groundwater contamination problem at this site has not proved easy to resolve. With NRC's guidance, Atlas produced a new clean-up plan. This plan had as its objective de-watering the tailings. The goal was to stop seepage from entering the groundwater and the Colorado River. This would be accomplished by drying out the tailings, the source of the contaminated seepage.⁴⁶⁹

NRC had already required Atlas to stop watering the tailings. Atlas had used water to control blowing tailings and limit radon emissions and Atlas objected strenuously when made to stop this practice.⁴⁷⁰ The company also agreed to expand the sprinkler mist-

⁴⁶³ See Letter from Richard Blubaugh, Vice Pres., Regulatory and Envtl. Affairs, Atlas Corp., to Director, NRC Office of Enforcement, attachment no. 2 at 1, 2 (Nov. 3, 1989) (on file with NRC/PDR, ACN. 8911070353); Memorandum for Docket File No. 40-3453, from Gary Konwinski, Project Manager, NRC Region IV 2 (Feb. 28, 1991) (on file with NRC/PDR, ACN. 9103130349).

⁴⁶⁴ See Memorandum to Docket File No. 40-3453, *supra* note 463, at 2. The State of Utah has strongly objected to this conclusion. "What this 'dilution is the solution to pollution' analysis fails to make clear is that while technically surface water quality standards may not be violated, there will still be a contaminant mass flow into the Colorado River that does incrementally degrade the river, even though this is difficult to measure." Division of Radiation Control, *supra* note 460, at 2.

⁴⁶⁵ See Letter from Edward Hawkins, *supra* note 462, at 1.

⁴⁶⁶ *Id.*

⁴⁶⁷ *Id.*

⁴⁶⁸ Memorandum to Docket File No. 40-3453, *supra* note 459, at 1.

⁴⁶⁹ *Id.* at 1-2.

⁴⁷⁰ Atlas asserted "that it was far more protective of the environment and the public health to continue pumping water into the tailings, so as to minimize air concentrations of Radon-222 and airborne particulates, than to discontinue this practice to address an

ing system to accelerate evaporation from the surface of the tailings. In addition, the company would drill new wells around the base of the tailings pile so that liquids could be pumped directly from the impoundment.⁴⁷¹ The goal was to pump seepage from the tailings pile at a rate of 10 gpm, treat it, and evaporate it.⁴⁷² However, the wells drilled for this purpose never produced as expected. In July 1990 Atlas estimated that the combined yield of 10 pumping wells was 3 to 4 gpm, and falling.⁴⁷³

Atlas did not hide its displeasure at the groundwater clean-up plan that had been imposed by the NRC.

We estimate a cost of \$25,000 to \$35,000 per gpm of solution recovered. This estimate does not include power, maintenance, or administrative costs. This is an unreasonable cost for Atlas to incur for an impractical approach to a situation that presents no significant risk to the environment or human health.⁴⁷⁴

Atlas' frustration increased when, in late 1989, they received a Notice of Violation and a fine of \$6,250 for excessive radon-222 concentrations in an unrestricted area.⁴⁷⁵ Atlas responded by pointing out that "NRC's rigid insistence upon the dewatering of tailings has now resulted in the predicted increase in airborne radon-222 concentrations."⁴⁷⁶

NRC has had no other ideas for resolving the groundwater contamination problem. In a letter responding to Atlas' complaints, the NRC seemed to have concluded, as Atlas had earlier, that the only answer to the problem was to accept higher levels of hazardous constituents in the groundwater. Atlas was told that "the pumping data and costs associated with well installation will be helpful in demonstrating that hazardous constituents have been reduced to levels as low as reasonably achievable."⁴⁷⁷ Although Atlas would have to continue pumping liquid from the tailings, the NRC did

insignificant hydrological issue." Letter from Richard Blubaugh, *supra* note 463, attach. no. 2 at 1, 2.

⁴⁷¹ Letter from Richard Blubaugh, Vice Pres., Regulatory and Evtl. Affairs, Atlas Corp., to Ramon Hall, Director, Uranium Recovery Field Office, NRC Region IV 2, 3 (July 18, 1990) (on file with NRC/PDR, ACN. 9009050037).

⁴⁷² Memorandum to Docket File No. 40-3453, *supra* note 459, at 2.

⁴⁷³ Letter from Richard Blubaugh, *supra* note 471, at 1.

⁴⁷⁴ *Id.* at 3.

⁴⁷⁵ See Letter from Richard Blubaugh, *supra* note 463, at 1 *passim*.

⁴⁷⁶ *Id.* at attach. no. 2 at 2.

⁴⁷⁷ Letter from L.A. Yandell, NRC Region IV, to Atlas Corporation 1 (Aug. 23, 1990) (on file with NRC/PDR, ACN. 9009040108).

suggest that Atlas eventually might wish to pursue an application for Alternate Concentration Limits.⁴⁷⁸

C. Move the Tailings

The citizens of the booming tourist community of Moab do have a plan for dealing with the Atlas tailings. They want the tailings moved away from the Colorado River and away from the tourist center. Local politicians, businesses, environmentalists, and even state officials support the idea of moving the tailings.⁴⁷⁹ These critics argue that in addition to the problem of contaminants entering the Colorado River and the dangers from blowing tailings, there is a real possibility of the pile being breached by floods.⁴⁸⁰ The Atlas tailings sit in both the flood plain of the Colorado River and the path of Moab Wash, an ephemeral stream which runs along the northeast end of the pile.⁴⁸¹ The Colorado River can rise to the bottom of the tailings impoundment during spring high water.⁴⁸²

About half of the approximately twenty uranium mill tailings piles now being reclaimed by the Department of Energy, under Title I of UMTRCA, will be moved at taxpayers' expense to more isolated and stable sites.⁴⁸³ Two alternative sites have been identified for the Atlas tailings. One site is in a box canyon 7 miles distant, and the other is near the airport 15 miles away.⁴⁸⁴ Advocates of the

⁴⁷⁸ *Id.* It is not clear why in 1992 NRC accepted and published in the Federal Register a date of Dec. 1998 as the estimated date for successful completion of groundwater corrective actions at the Moab tailings site. See Atlas Corp., Moab Mill, Reclamation Schedules, 57 Fed. Reg. 29,541, 29,542 (1992). See also 59 Fed. Reg. 30,814 (1994) (extending the projected completion date to Dec. 1999). As the State of Utah noted, if this Dec. 1998 date "involves the potential use of alternate concentration limits (ACLs), this should be made clear." Division of Radiation Control, *supra* note 460, at 1, 2.

⁴⁷⁹ See, e.g., Sam Taylor, *NRC Decision on Tailings Has Locals up in Arms*, THE TIMES-INDEPENDENT (Moab, Utah), July 29, 1993, at A1, A4; Adrien Taylor, *Gov. Leavitt Joins Chorus of Critics Opposed to Atlas Tailings Capping Plan*, THE TIMES-INDEPENDENT (Moab, Utah), Sept. 2, 1993, at A1; Division of Radiation Control, *supra* note 460, at 1 *passim*; Division of Radiation Control, *supra* note 448, at 1 *passim*.

⁴⁸⁰ Lance Christie, *Cleaning Up the Atlas Uranium Mill Tailings* (paid "public information report"), THE TIMES-INDEPENDENT (Moab, Utah), July 29, 1993, at A3.

⁴⁸¹ See Division of Radiation Control, *supra* note 460, at 8; Reclamation of Atlas Corporation's Uranium Mill Facility, *supra* note 453, at 14,912, 14,913.

⁴⁸² Christie, *supra* note 480, at A3; ATLAS DRAFT E.I.S., *supra* note 446, at 3-18, 4-13.

⁴⁸³ See 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 8-4; OFFICE OF ENVTL. RESTORATION AND WASTE MANAGEMENT, U.S. DEPT. OF ENERGY, ANNUAL STATUS REPORT ON THE URANIUM MILL TAILINGS REMEDIAL ACTION PROGRAM at A-3 (Dec. 1992).

⁴⁸⁴ Reclamation of Atlas Corporation's Uranium Mill Facility, *supra* note 453, at

move argue that reclaiming the tailings in place fails almost every test set forth in federal regulations, including remoteness from populated areas; ability to isolate contaminants from groundwater; and minimization of erosion and dispersion of the tailings by natural forces.⁴⁸⁵

In July 1993 the NRC issued a finding that the reclamation of the Atlas tailings in place "would not have a significant impact on the environment."⁴⁸⁶ In what has become almost a routine procedure, similar Findings of No Significant Impact (FONSI) have been issued for private mills, some of which face possible damage from future flooding.⁴⁸⁷ What was not routine was the political furor that erupted in Moab after the Finding of No Significant Impact was issued.⁴⁸⁸ An unusually broad coalition of business interests, environmentalists, and the State of Utah opposed the NRC decision.⁴⁸⁹ As a result of this protest the NRC withdrew the FONSI⁴⁹⁰ and subsequently announced that it would produce an Environmental Impact Statement to assess the necessity for moving the Atlas tailings.⁴⁹¹

The President of Atlas responded to the possibility of having to move the tailings by threatening bankruptcy.⁴⁹² He warned that if

14,912, 14,913. The site near the airport is analyzed in detail in ATLAS DRAFT E.I.S., *supra* note 446, at 2-14 to 2-22.

⁴⁸⁵ See *supra* notes 90-92 and accompanying text. The main argument against moving the tailings is increased costs. The cost of reclaiming the tailings where they lie is estimated to be \$13 million to \$16 million. Moving the tailings is estimated to cost \$94 million to \$114 million. ATLAS DRAFT E.I.S., *supra* note 446, at xxi, 2-33, 5-1 to 5-6. Cost is one factor that the NRC must consider in making reclamation decisions. See *supra* note 92. However, the mandate to consider costs also applies to the Title I sites being reclaimed by the Dept. of Energy, half of which will be moved. 42 U.S.C. § 2022(a) (1988). See also 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 8-2, 8-3.

⁴⁸⁶ Atlas Mineral Corp., 58 Fed. Reg. 38,796, 38,797 (1993).

⁴⁸⁷ See, e.g., Finding of No Significant Impact, *supra* note 175 at 39,584 (Homestake); Finding of No Significant Impact, *supra* note 269, at 33,285 (Western Nuclear, Inc.).

⁴⁸⁸ See, e.g., Sam Taylor, *supra* note 479, at A1, A4; *County Council Blasts NRC Plan on Dealing with Atlas Tailings Pile*, THE TIMES-INDEPENDENT (Moab, Utah), Aug. 19, 1993, at A1, A3.

⁴⁸⁹ See *supra* note 479 and accompanying text.

⁴⁹⁰ Atlas Corporation, 58 Fed. Reg. 52,516 (1993); Adrien Taylor, *NRC to Withdraw Earlier Position on Atlas Tailings under Pressure, Hatch Says*, THE TIMES-INDEPENDENT (Moab, Utah), Sept. 30, 1993, at A1.

⁴⁹¹ Reclamation of Atlas Corporation's Uranium Mill Facility, *supra* note 453, at 14,912.

⁴⁹² Video tape of Civic Dialogue's Moab Town Meeting, broadcast by KUED (Salt Lake City) (Feb. 22, 1994) (on file with author). see generally *Tailings May Bankrupt Atlas* ENR, Mar. 28, 1994, at 21.

NRC decided for removal the financially troubled company would cease to exist. "The tailings pond will become a Superfund site that will cost hundreds of millions of dollars to reclaim."⁴⁹³ This threat was premature. In its 1996 Draft Environmental Impact Statement on the Atlas site, the NRC recommended against moving the tailings.⁴⁹⁴ NRC essentially agreed with Atlas that the volume of water in the Colorado River diluted seepage from the tailings pile. "[W]ater quality downstream from the tailings pile does not differ measurably from that upstream of the pile."⁴⁹⁵

The worst case scenario analyzed in the Draft E.I.S. was a failure of the reclaimed tailings pile during a flood. NRC hypothesized that 20% of the pile, or about 2 million tons of tailings, would enter the Colorado River in such a failure.⁴⁹⁶ Even in this worst case, the NRC concluded that most water quality standards in the river (uranium being the exception) would not be violated during a pile failure because of the great dilution provided by the flood.⁴⁹⁷ The report did note that "although the immediate effects of a maximum pile failure are forecast to last only several days, the perception of the region's safety and desirability for Colorado River-based recreational experience could be noticeably diminished, no matter what the actual safety factor might be."⁴⁹⁸

The regulations implementing UMTRCA provide a clear means for dealing with such threats. Companies are required to put up a bond, cash deposit, or similar financial security to insure reclamation if the company defaults. *See supra* notes 100-101 and accompanying text. Since at least 1990, Atlas's required surety has only been \$6.5 million. Letter from Ramon Hall, Director, UFRO, NRC Region IV, to Richard Blubaugh, Atlas Corporation at 1 and attach. at 10 (Dec. 13, 1990) (on file with NRC/PDR, ACN. 9101090124). However, since 1992 the NRC has been able to count promised federal Title X monies in determining the sufficiency of a company's surety. *See supra* notes 367-372 and accompanying text.

⁴⁹³ Videotape of Civic Dialogue's Moab Town Meeting, *supra* note 492. *See also*, *Tailings May Bankrupt Atlas*, *supra* note 492.

⁴⁹⁴ ATLAS DRAFT E.I.S., *supra* note 446, at xxi, 2-26.

⁴⁹⁵ *Id.* at 4-22. Possible exceptions include suspended solids, pH, manganese, and gross alpha. However, the Draft E.I.S. argues that given the relatively high concentrations of contaminants already found in the Colorado River, the tailings contribute only trivial percentages of most contaminants. *Id.* at 4-22 to 4-27.

The Draft E.I.S. does admit that the groundwater at the tailings pile will continue to be impacted, after reclamation, by periodic Colorado River flooding and rewetting of the tailings. This contamination of the groundwater will continue until the entire leachable content of the pile is leached out. However, "[b]ecause groundwater on the Atlas side of the river is not used for any purpose, the continued contamination associated with the tailings would not impact groundwater use." *Id.* at 4-13, 4-14.

⁴⁹⁶ *Id.* at xvii, 4-8, 4-9, 4-27, 4-55.

⁴⁹⁷ *Id.* at 4-8.

⁴⁹⁸ *Id.* at 4-55.

XII. THE END OF DELAY

In October 1991 the EPA announced an agreement with the NRC to set enforceable deadlines for reclamation of non-operational uranium mill tailings impoundments.⁴⁹⁹ Uranium milling companies would no longer be allowed to delay reclamation or to determine the pace at which reclamation would occur. "Milestones" or enforceable deadlines would be set for each phase of reclamation.⁵⁰⁰ EPA's stated goal was to have a permanent cover in place over all non-operational tailings impoundments by December 31, 1997.⁵⁰¹ Deadlines were also set for groundwater restoration.⁵⁰² But, as seen in the eight case studies, these deadlines for groundwater cleanup varied widely and, in some cases, were overly optimistic. Companies were warned that if they refused to voluntarily cooperate in establishing reclamation deadlines, then the NRC would "impose the appropriate license amendments by order. . . ."⁵⁰³

The impetus for the government's new concern with rapid reclamation came from a number of successful suits by environmental groups in the 1980s.⁵⁰⁴ The subject of these suits was not UMTRCA, but rather EPA's failure to enforce section 112 of the Clean Air Act.⁵⁰⁵ In the last year of the Carter Administration EPA added radionuclides to the list of section 112 hazardous air pollutants that it was responsible for regulating.⁵⁰⁶ This listing raised the

⁴⁹⁹ Memorandum of Understanding between EPA and NRC, 56 Fed. Reg. 55,434, 55,435 (1991) [hereinafter Memorandum]. See also Health and Environmental Standards for Uranium and Thorium Mill Tailings: Final Rule, 58 Fed. Reg. 60,340, 60,340-356 (1993) [hereinafter Final Rule]; Uranium Mill Tailings Regulations, 59 Fed. Reg. 28,220, 28,220-231 (1994).

⁵⁰⁰ See Memorandum, *supra* note 499, at 55,434-435; Final Rule, *supra* note 499, at 60,346, 60,352.

⁵⁰¹ Memorandum, *supra* note 499, at 55,435.

⁵⁰² See Final Rule, *supra* note 499, at 60,346; Uranium Mill Tailings Regulations, *supra* note 499, at 28,227.

⁵⁰³ Memorandum, *supra* note 499, at 55,434.

⁵⁰⁴ See *infra* notes 513-517 and accompanying text.

⁵⁰⁵ 42 U.S.C. § 7412 (1988) (superceded 1990).

⁵⁰⁶ National Emission Standards for Hazardous Air Pollutants, 44 Fed. Reg. 76,738 (1979). After the official listing of radionuclides as an air pollutant, the EPA was required to set emission standards for major sources of the pollutant. 42 U.S.C. § 7412(b)(1)(B) (1988). These major sources would include some sources that were also licensed by the NRC, such as uranium mills, uranium fuel cycle facilities, and nuclear power plants. Other sources of radionuclide emissions, not licensed by the NRC, include hospitals, uranium mines, research facilities, coal-fired fossil burners, elemental phospho-

specter of direct regulation by two federal agencies for those sources of radionuclides that were also licensed by the NRC.

However, the anti-regulation forces that took over the EPA in the early days of the Reagan Administration were reluctant to begin any direct regulation of radionuclides.⁵⁰⁷ The EPA developed various subterfuges to avoid this dual regulation. The Agency argued that regulating radionuclides was impossible because of their complexity,⁵⁰⁸ and that additional time was needed to study the problem, perhaps as much as nine years.⁵⁰⁹ The EPA also ignored Congressional deadlines. For some emission sources, the EPA did issue proposed standards, but no final standards followed.⁵¹⁰ Other proposed standards were issued and then withdrawn.⁵¹¹ In the case of uranium mill tailings, the EPA declared that new standards for reclaimed tailings were not necessary as the standards promulgated under UMTRCA also satisfied section 112 of the Clean Air Act.⁵¹² Environmental groups challenged this and other Clean Air Act decisions of the Reagan Administration.⁵¹³ The most important of several court victories for these environmental groups came in 1987 in a key case that dealt with EPA emission standards for vinyl chloride.⁵¹⁴

Vinyl chloride was listed as a hazardous air pollutant under section 112 of the Clean Air Act, as were radionuclides. In the *Vinyl Chloride* decision, the court found that section 112 required the EPA to set basic emission standards without considering factors

rous plants and phosphogypsum stacks. See generally Goldsmith, *supra* note 66, at 107-09.

⁵⁰⁷ See Goldsmith, *supra* note 66, at 109-113, 120, 131; John D. Graham, *The Failure of Agency-Forcing: The Regulation of Airborne Carcinogens under Section 112 of the Clear Air Act*, 17 LAND USE & ENVTL. L. REV. 399, 412-13 (1986). In addition to the antiregulatory stance of the Reagan administration, Dwyer emphasizes the EPA's reluctance to implement health based standards that it felt were unrealistic, costly, and never intended by Congress to be taken literally. John P. Dwyer, *The Pathology of Symbolic Legislation*, 17 ECOLOGY L.Q. 233, 277-81 (1990).

⁵⁰⁸ Monson, *supra* note 17, at 570.

⁵⁰⁹ Goldsmith, *supra* note 66, at 110.

⁵¹⁰ *Id.* at 109-113. See also Graham, *supra* note 507, at 412-13.

⁵¹¹ See National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule, 54 Fed. Reg. 51,654, 51,658 (1989) [hereinafter 1989 NESHAPS].

⁵¹² Standards Licensed Sites, *supra* note 20, at 45,939-940. See also Health and Environmental Standards for Uranium and Thorium Mill Tailings: Proposed Rule, 58 Fed. Reg. 32,174, 32,183 (1993).

⁵¹³ See 1989 NESHAPS, *supra* note 511, at 51,658; Dwyer, *supra* note 507, at 269-71; Collins, *supra* note 16, at 508-09.

⁵¹⁴ *Natural Resources Defense Council, Inc. v. Environmental Protection Agency*, 824 F.2d 1146 (D.C. Cir. 1987) [hereinafter *Vinyl Chloride*].

such as cost and technological feasibility.⁵¹⁵ An "acceptable" or "safe" risk level for the hazardous pollutant, the court found, must first be determined using health criteria alone.⁵¹⁶ The uranium industry was obviously apprehensive about a radon emission limit that initially would be set using only health criteria. As if to confirm the companies' worst fears, environmental groups argued after the *Vinyl Chloride* decision that the EPA should set a zero emission level for air pollutants, such as radionuclides, for which there is no known safe threshold level.⁵¹⁷

The *Vinyl Chloride* decision forced the EPA to withdraw past emission standards issued under section 112 of the Clean Air Act. Now there would be new standards that would probably be more stringent and EPA would administer these standards directly. In December 1989, the EPA promulgated new standards for controlling radon emissions from uranium mill tailings.⁵¹⁸ Surprisingly these new standards retained the previous emission level for reclaimed tailings of 20 pCi/m²/s.⁵¹⁹ What was new, and for the uranium industry most upsetting, were the new regulations for unreclaimed tailings impoundments. Companies with tailings impoundments either on stand-by (waiting for market conditions to improve) or operational and still receiving tailings also would have to meet the 20 pCi/m²/s standard.⁵²⁰ This rule, the EPA noted, "will have the

⁵¹⁵ *Id.* at 1146, 1163, 1165.

⁵¹⁶ *Id.* at 1165. After this initial step, the EPA could then consider technological and cost factors in adjusting the standard to assure it provided "an ample margin of safety." *Id.* at 1152, 1165. See also Gary E. Marchant & Dawn P. Danzeisen, Comment, "Acceptable" Risk for Hazardous Air Pollutants, 13 HARV. ENVTL. L. REV. 535, 538-39 (1989); Alan J. Goldberg, Note, *Toward Sensible Regulation of Hazardous Air Pollutants under Section 112 of the Clean Air Act*, 63 N.Y.U. L. REV. 612, 641-43 (1988); Mark W. Ciaravella, Note, *Regulation of Hazardous Air Pollutants under Section 112 of the Clean Air Act Amendments of 1990*, 15 ENERGY L.J. 485, 485-87 (1994).

⁵¹⁷ Marchant & Danzeisen, *supra* note 516. The Natural Resources Defense Council had argued for a zero-emission standard in *Vinyl Chloride*. *Vinyl Chloride*, 824 F.2d at 1152. However, in explaining its later rulemaking the EPA emphasized that the court did not require a finding that "safe" means "risk-free." The court said that EPA itself must decide what risks are acceptable in the world in which we live. They cited driving a car or breathing city air as risk-laden activities that society does not consider unsafe. 1989 NESHAPS, *supra* note 511, at 51,684-85.

⁵¹⁸ 1989 NESHAPS, *supra* note 511, at 51,654. See also Collins, *supra* note 16, at 510-12.

⁵¹⁹ 1989 NESHAPS, *supra* note 511, at 51,683, 51,702 (codified at 40 C.F.R. § 61.222 (1990)). For the first time companies were required to monitor to assure that this emission standard was achieved. Under UMTRCA, the 20 pCi/m²/s limit was assumed to be achieved once an acceptable reclamation plan had been implemented. *Id.* at 51,683, 51,709-11.

⁵²⁰ *Id.* at 51,680 (codified at 40 C.F.R. § 61.252(a) (1990)).

practical effect of requiring the mill operators to keep their piles wet or covered.”⁵²¹

This action led to another ruling even more objectionable to the industry. Wetting tailings to lower radon emissions could increase seepage and groundwater pollution. Therefore, EPA decided to eliminate the liner exemption granted in 1983 to existing unlined tailings impoundments.⁵²² Unlined tailings impoundments could no longer be considered operational.⁵²³ Equally, if a tailings impoundment were full, or the mill it served dismantled, then it, too, would be considered non-operational.⁵²⁴ The final blow was that these non-operational tailings impoundments were given a two year reclamation deadline.⁵²⁵

As the majority of uranium mill tailings piles were unlined, these regulations meant that the EPA was closing down most of what remained of the conventional uranium milling industry. Although it was understood that most companies could not reclaim in two years, the deadline was a wake up call for rapid reclamation. The American Mining Congress (AMC) indignantly labeled the new 20 pCi/m²/s emission standard for operating impoundments “arbitrary and capricious.”⁵²⁶ The new liner requirement was called “illegal and infeasible.”⁵²⁷ The AMC stated with prescience that, “as a practical matter, the liner requirement will require the closure of the Homestake, Quivira, and Pathfinder mill tailings sites.”⁵²⁸

⁵²¹ *Id.* Indeed, this was the point of the new standard, since “the risks from mill tailings piles can increase dramatically if they are allowed to dry and remain uncovered.” *Id.*

⁵²² *Id.* (codified at 40 C.F.R. § 61.252(c) (1990)). See also Collins, *supra* note 16, at 511-12.

⁵²³ 1989 NESHAPS, *supra* note 511, at 51,702 (codified at 40 C.F.R. § 61.221(b) (1990)).

⁵²⁴ *Id.*

⁵²⁵ *Id.* However, “[i]f the two year period is not enough time for these piles to dry out and be covered and disposed of then EPA is prepared to develop expeditious compliance schedules in consultation with the affected parties. . . .” *Id.* at 51,683.

⁵²⁶ Petition of the American Mining Congress for Reconsideration and Stay of Radionuclides NESHAPS, Before the U.S. Env'tl. Protection Agency 25 (Feb. 13, 1990) (on file with EPA Air Docket, Docket No. A-79-11).

⁵²⁷ *Id.* at 27.

⁵²⁸ *Id.* at 28. This was to prove true. Companies with unlined tailings impoundments that had maintained an operational status were soon pressured to begin reclamation. For example, Homestake was threatened with a fine of up to \$25,000 a day for being out of compliance with EPA regulations. Letter from A. Stanley Meiburg, EPA Region 6, to David Crouch, Homestake Mining Co. 1, 2 (Dec. 10, 1990) (on file with NRC/PDR, ACN. 9101150178). Quivira was told unless they began reclaiming their unlined #2 tailings impoundment it would be considered in non-compliance with EPA

Implementation of the new standards became muddled in 1990 with the intervention of Congress. After one failed attempt by Wyoming's Senator Simpson to nullify EPA's rules, a weaker version was enacted. This addition to the Clean Air Act Amendments of 1990 gave EPA the possibility of eliminating dual regulation for those radionuclide sources that were also licensed by the NRC.⁵²⁹ If the EPA Administrator determined, by rule, that the NRC regulatory program "provides an ample margin of safety to protect the public health," then EPA would not have to promulgate standards.⁵³⁰

In 1991, the EPA announced that it planned to rescind the Clean Air Act regulations it had issued in 1989 for non-operational uranium mill tailings impoundments.⁵³¹ However, EPA emphasized that this rescission would take place only after UMTRCA's regulations incorporated the goal of rapid reclamation and enforceable deadlines.⁵³² Clearly EPA realized that if UMTRCA did not in fact achieve the same purpose as the rescinded regulations, then the EPA would again be challenged by the environmental groups who had sued successfully in the past.

In an effort to avoid further unproductive litigation, EPA developed a consensus approach for new rule making. The agency held direct discussions with all the concerned parties: environmental groups, the uranium industry, and the NRC.⁵³³ Groups representing industry and the environment signed a "settlement agreement" in 1993.⁵³⁴ The parties agreed to avoid the delays and expense of fu-

regulations. See Letter from John Hepola, EPA Region 6, to Bill Ferdinand, Rio Algom Mining Corp. 2 (Jan. 18, 1991) (on file with NRC/PDR, ACN. 9102280029).

The decision of these mills to close rather than build new lined impoundments probably was made easier by the continued fall in uranium prices in the early 1990s.

⁵²⁹ Clean Air Act Amendments of 1990, Pub. L. No. 101-549, § 112(d)(9), 42 U.S.C. § 7412 (Supp. V 1993). See generally Collins, *supra* note 16, at 513-15; Goldsmith, *supra* note 66, at 121-24, 138-41, 144-52.

⁵³⁰ 42 U.S.C. § 7412 (Supp. 1993).

⁵³¹ National Emission Standards for Hazardous Air Pollutants: Notice of Proposed Rulemaking, 56 Fed. Reg. 55,432 (1991) [hereinafter Proposed Rulemaking]. See also Final Rule, *supra* note 499, at 60,342. The standards to be rescinded are found at 40 C.F.R. part 61, subpart T.

⁵³² Proposed Rulemaking, *supra* note 531, at 55,433. See also Final Rule, *supra* note 499, at 60,342, 60,346.

⁵³³ Final Rule, *supra* note 499, at 60,345.

⁵³⁴ Proposed Settlement; Uranium Mill Tailings Disposal Litigation, 58 Fed.Reg. 17,230 (1993). See also Final Rule, *supra* note 499, at 60,345, 60,350. NRC did not sign the agreement, but stated its agreement in principle. Uranium Mill Tailings Regulations, *supra* note 496, at 28,225.

ture legal action and to get on with the business of reclamation.⁵³⁵ The settlement agreement gave victories to both industry and environmentalists. The uranium industry got rid of an unrealistic two year reclamation deadline, and saw the end of onerous dual federal regulation.⁵³⁶ The price paid to the environmental litigants for accepting the rescission was the assurance that radon emissions would be permanently and quickly controlled. NRC now includes enforceable interim deadlines in its licenses.⁵³⁷ These enforceable "milestones" move companies toward the goal of a permanent cover over all nonoperational tailings impoundments by the end of 1997.⁵³⁸

CONCLUSION

Title II of the Uranium Mill Tailings Radiation Control Act, which regulated reclamation in the private uranium industry, was clearly the wrong law for the times. Soon after the law was passed, newly elected Republicans brought an end to ten years of federal environmental activism. The economic prospects of the uranium industry also changed dramatically in this period. In 1978 Congress had planned to protect the public health with new below grade, lined, tailings impoundments. These impoundments would be properly sited to guard against floods, earthquakes, and erosion by wind and rain. However, after the uranium market crashed in 1980, no new tailings impoundments were built. Instead of supervising new construction, federal and state regulators found that their main task was to supervise the burial of an industry. UMTRCA was not written with this economic future in mind.

Administrators and politicians who oversaw the implementation of UMTRCA made adjustments to fit the changed economic and

⁵³⁵ Final Rule, *supra* note 499, at 60,345.

⁵³⁶ Uranium mills also were given the possibility of extending an interim deadline if the 20 pCi/m²/s emission level was being met. Final Rule, *supra* note 499 at 60,347; Uranium Mill Tailings Regulations, *supra* note 499, at 28,223-224, 28,227. In addition, companies could continue to use a portion of existing impoundments to receive in-situ mining wastes and other similar waste from outside sources. These outside wastes would be carefully monitored by NRC. Final Rule, *supra* note 499, at 60,347-348; Uranium Mill Tailings Regulations, *supra* note 499, at 28,224, 28,228.

Finally, an objectionable emission monitoring requirement was clarified. Companies would only have to do a one-time verification on their permanent cover to assure that emission levels were no greater than 20 pCi/m²/s, when averaged over the impoundment. Uranium Mill Tailings Regulations, *supra* note 499, at 28,222.

⁵³⁷ Final Rule, *supra* note 499, at 60,352.

⁵³⁸ *Id.* at 60,346. See also Uranium Mill Tailings Regulations, *supra* note 499, at 28,220-226.

political climate. Given the sympathy that existed for the stricken uranium industry and the general pro-industry climate in Washington in the 1980s, it is not surprising that these adjustments favored the uranium industry. The new directions taken in implementing UMTRCA were an odd mixture of federal intervention and non-intervention. The non-intervention took the form of a lenient attitude about when reclamation would begin and with what speed it would proceed.⁵³⁹ In addition, regulations that seemed to require the relocation of tailings, if their long term safety could not be guaranteed, were loosely interpreted so as to avoid having to move tailings piles being reclaimed by private industry.

There was also an interventionist aspect to the attempts to make the law fit the times. In 1992 Congress transferred the financial burden for reclaiming 55 million metric tons of tailings from private industry to the federal taxpayer.⁵⁴⁰ The federal government promised to reimburse private companies for the costs of reclaiming that portion of their tailings that had been produced under federal contract.

In the late 1980s, as a result of court decisions on earlier suits by environmental groups, the pendulum began to swing back toward a more literal and stringent interpretation of UMTRCA. The NRC has been forced to embrace expeditious reclamation, at least as concerns covering the tailings. Most companies now will be required to have a permanent cover over their tailings by the end of 1997.⁵⁴¹

It is, however, still too early to conclude that some equitable balance has been struck between relief for a dying industry and reasonable reclamation requirements. The other major dispensation from the rules given these private companies will not be rescinded. Private companies will not be forced to pay for moving tailings to more protected sites. In contrast, about half of the more than twenty Title I abandoned tailings sites being reclaimed by the Department

⁵³⁹ One often overlooked benefit from delaying reclamation is that companies could use the delay to pay for future reclamation. Monies that otherwise would have been spent on reclamation could be invested, and the interest compounded. As a hearing officer noted in making this point to a representative from Homestake Mining Co. "Twenty million dollars not spent, or used alternatively, is going to earn you money. . . . A year delayed is a year of money used and if I present your \$20 million, it makes a million bucks. . . ." *Public Hearings*, *supra* note 130, at 125 (statement of Mr. Bunger).

⁵⁴⁰ See *supra* notes 361-369 and accompanying text.

⁵⁴¹ Final Rule, *supra* note 499, at 60,346, 60,352. See also Uranium Mill Tailings Regulations, *supra* note 499, at 28,220-226.

of Energy are being moved.⁵⁴² When the government pays for the move, the question of costs seems to be less of an issue.

The main reason it is still too early to make a final assessment of UMTRCA, Title II, is that we do not know what NRC will do about groundwater restoration. So far the signals are very mixed. By the late 1980s NRC was finally requiring all companies to initiate groundwater corrective action plans. Yet, the NRC also accepted, and published in the Federal Register, incredibly unrealistic completion dates for some of the most difficult groundwater clean-up problems.⁵⁴³ In addition, in Wyoming, the NRC has required only minimal bonds to cover groundwater restoration.⁵⁴⁴ The problem of groundwater contamination was greatly exacerbated by NRC's *laissez faire* approach to reclamation in the 1980s. This problem is more intractable than the problem of radon, and possibly a greater future danger to health and the environment. Yet, during the late 1990s, the NRC could literally write off the groundwater contamination problem with a liberal granting of eased clean-up standards in the form of Alternate Concentration Limits.

If most companies are allowed to complete reclamation without restoring contaminated groundwater, then, in the most egregious cases, UMTRCA, Title II, will have achieved little more than protection against the questionable hazard of outdoor radon emissions. Polluted groundwater would remain and, in some cases, reclaimed tailings piles could be infiltrated and dispersed by future floods.

On the other hand, NRC may insist companies follow the example of Pathfinder, Homestake, and Quivira, and undertake a serious effort to restore polluted groundwater. In this best case scenario, NRC could still grant eased standards in the form of Alternate Concentration Limits. However, these standards would be limited to those rare situations where polluted groundwater had little potential for being used, or for migrating to other aquifers. Eased standards might also be appropriate where a long term and innovative remediation effort had apparently achieved all it could. This would appear to be what the regulations for Alternate Concentration Limits require today.⁵⁴⁵ It will be several years, however, before we can assess NRC's resoluteness in enforcing these regulations.

⁵⁴² See 2 OFFICE OF RADIATION PROGRAMS, *supra* note 28, at 8-4; OFFICE OF ENVTL. RESTORATION AND WASTE MANAGEMENT, *supra* note 483, at A-3.

⁵⁴³ See, e.g., *supra* notes 213, 306 and accompanying text, and notes 350 and 478.

⁵⁴⁴ See *supra* notes 301-305, 346-351, 434-444 and accompanying text.

⁵⁴⁵ See *supra* notes 214-217 and accompanying text.